

**Ontario Geological Survey
Report 225**

**Geology of
Natal and Knight Townships
Districts of Sudbury and Timiskaming**

**by
M.W. Carter**

1983



**Ministry of
Natural
Resources**

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Printed in Canada

ISSN 0704-2582
ISBN 0-7743-7805-0

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Carter, M.W.

1983: Geology of Natal and Knight Townships, Districts of Sudbury and Timiskaming: Ontario Geological Survey, Report 225, 74p. Accompanied by Map 2465, scale 1:31 680.

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GEOLOGICAL MAP

(back pocket)

Map 2465 (coloured) — Knight and Natal Townships, Districts of Sudbury and Timiskaming.

Scale 1 inch to ½ mile (1:31,680).

ABSTRACT

This report describes the geology and mineral deposits in Natal and Knight Townships, which comprise an area of 210 km² centred about 48 km east of Gogama.

Consolidated rocks in the map-area belong to the Early and Middle Precambrian. Unconsolidated rocks comprise sand and gravel and swamp and stream deposits of the Pleistocene and Recent periods of the Phanerozoic.

Early Precambrian (Archean) rocks comprise a suite of metamorphosed, ultramafic to felsic, extrusive and possibly intrusive rocks and associated pyroclastics, interbedded with subordinate metasediments; intrusive felsic to intermediate plutonic rocks; and diabase dikes. The metavolcanics belong to the subalkalic and alkalic suites, and, together with the metasediments, are folded about a northwesterly trending and plunging synclinal axis located in central Natal and southwestern Knight Townships. The intrusive plutonic rocks comprise altered massive and porphyritic granitoid rocks. Diabase dikes form a parallel, northwest-trending dike swarm which post-dates the granitoid rocks.

The Middle Precambrian is represented by Nipissing-type diabase and clastic rocks of the Gowganda Formation which belong to the Cobalt Group of the Huronian Supergroup.

Faults trend northwesterly and northerly. The major faults are the Natal Lake Fault which trends N45W and is located in Natal Township, and the Pigeon Lake Fault which trends N35W on average and is located in Knight Township. The Natal Lake Fault has a vertical component of movement and may be a gravity fault. The north-trending faults occur in eastern Natal and eastern Knight Townships and are gravity faults with downthrow to the east.

Mineralization in the map-area consists of gold, silver, nickel, copper, cobalt, and asbestos. Gold, silver, copper, cobalt and asbestos are vein-type deposits, the most important mineralization being that of gold. Nickel occurs as concordant stratabound deposits associated with komatiitic rocks.



Figure 1. Key map showing location of Natal and Knight Townships.

Conversion Factors for Measurements in Ontario Geological Survey Publications

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL

SI Unit	Multiplied by	Gives
1 mm	0.039 37	inches
1 cm	0.393 70	inches
1 m	3.280 84	feet
1 m	0.049 700 7	chains
1 km	0.621 371	miles (statute)

1 cm ²	0.155 0	square inches
1 m ²	10.763 9	square feet
1 km ²	0.386 10	square miles
1 ha	2.471 054	acres

1 cm ³	0.061 02	cubic inches
1 m ³	35.314 7	cubic feet
1 m ³	1.358 0	cubic yards

1 L	1.759 755	pints
1 L	0.879 677	quarts
1 L	0.219 969	gallons

1 g	0.035 273 96	ounces (avdp)
1 g	0.032 150 75	ounces (troy)
1 kg	2.204 62	pounds (avdp)
1 kg	0.001 102 3	tons (short)
1 t	1.102 311	tons (short)
1 kg	0.000 984 21	tons (long)
1 t	0.984 208 5	tons (long)

1 g/t	0.029 166 6	ounce (troy)/ ton (short)
1 g/t	0.583 333 33	pennyweight/ ton (short)

CONVERSION FROM IMPERIAL TO SI

Imperial Unit	Multiplied by	Gives
LENGTH		
1 inch	25.4	mm
1 inch	2.54	cm
1 foot	0.304 8	m
1 chain	20.116 8	m
1 mile (statute)	1.609 344	km

AREA		
1 square inch	6.461 6	cm ²
1 square foot	0.092 903 04	m ²
1 square mile	2.589 988	km ²
1 acre	0.404 685 6	ha

VOLUME		
1 cubic inch	16.387 064	cm ³
1 cubic foot	0.028 316 85	m ³
1 cubic yard	0.764 555	m ³

CAPACITY		
1 pint	0.568 261	L
1 quart	1.136 522	L
1 gallon	4.546 089	L

MASS		
1 ounce (avdp)	28.349 523	g
1 ounce (troy)	31.103 476 8	g
1 pound (avdp)	0.453 592 37	kg
1 ton (short)	907.184 74	kg
1 ton (short)	0.907 184 74	t
1 ton (long)	1016.046 908 8	kg
1 ton (long)	1.016 046 908 8	t

1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	30.0	pennyweight/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE—Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in cooperation with the Coal Association of Canada.

Geology of Natal and Knight Townships

Districts of Sudbury and Timiskaming

by
M.W. Carter¹

INTRODUCTION

LOCATION AND ACCESS

The Townships of Natal and Knight cover an area of about 210 km² and are centred about 48 km east of Gogama. Natal Township lies in the District of Sudbury and Knight Township in the District of Timiskaming. The map-area is bounded approximately by Longitudes 80°55' to 81°12' W and Latitudes 47°40' to 47°45'30" N.

Access is moderately good for Knight Township but poor for Natal Township. The former can be reached by water from the south by entering the West Montreal River system at the intersection of the river and Highway 580 in north Tyrrell Township. This provides access to most parts of the township. By road, the southwestern part of Knight Township and the eastern part of Natal Township can be reached by following the Ontario Hydro road northwards from its intersection with Highway 580 in northwestern Tyrrell Township. From these two access points, all parts of Knight Township and the eastern quarter of Natal Township can be reached. The rest of Natal Township is best reached by float-equipped fixed-wing aircraft, using Natal, Seganku, and several unnamed lakes in the western and northwestern parts of the township.

PHYSIOGRAPHY

The map-area is one of moderate relief, the maximum being 150 m. The most rugged terrain occurs in Natal Township in country underlain predominantly by Early Precambrian metavolcanics. These form rounded knolls, culminating in an unnamed peak of 150 m relief in northwestern Natal Township where a disused fire tower is situated. In Knight Township maximum relief is about 45 m, in terrain underlain both by Early Precambrian metavolcanics and Middle Precambrian sedimentary rocks and diabase sills. The Middle Precambrian rocks form elongated, north-south ridges reflecting the prevailing strike. Only in the central part of Knight Township are there extensive areas covered by glacial and swamp deposits. Sand and gravel cover less extensive areas in southwestern Knight Township.

Drainage is easterly in Natal Township into Pigeon and Duncan Lakes located in Knight Township, thence northerly and easterly via the West Montreal River in eastern Knight Township to the Montreal River, which drains ultimately into the St. Lawrence River.

¹Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Approved for publication by the Chief Geologist, Ontario Geological Survey, December 23, 1980. This report is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

NATAL AND KNIGHT TOWNSHIPS

PREVIOUS GEOLOGICAL WORK

Geological investigations began in the area in 1896 when Burwash (1897) examined the country along the Nipissing-Algonia Line which divides Natal and Knight Townships.

During the period 1908-1910, Collins (1910, 1913) mapped Knight Township at a scale of 1 inch to 1 mile in the course of his mapping of the Gowganda Mining Division.

In 1925 Finley (Gledhill 1927) mapped Natal Township at a reconnaissance scale of 1 inch to 1½ miles as part of a larger area comprising the Townships of Burrows, Kemp, Mond, Cabot, Kelvin and Natal.

Later, in 1931, Graham (1932) mapped Knight Township and the eastern part of Natal Township at a scale of 1 inch to ¾ mile.

In 1973, Closs and Sado (1973) carried out a combined reconnaissance, consisting of geochemical exploration and a Quaternary geology survey, in Natal Township as part of a larger survey of Halliday, Midlothian, Kelvin, Natal, Churchill and Macmurchy Townships.

PRESENT GEOLOGICAL SURVEY

Field work for this project was carried out during the summer of 1974 using vertical aerial photographs at a scale of 1 inch to ¼ mile supplied by the Ontario Division of Forests. Pace-and-compass traverses were run at intervals of about ¼ mile to investigate outcrop areas observed on the photographs, or areas of potential rock exposure. The traverses were run at right angles to the strike wherever it could be determined. Shoreline exposures were examined by canoe and studied in greater detail.

Geological data were recorded directly onto acetate sheets attached to the aerial photographs carried on traverse. These data were then transferred to 1 inch to ¼ mile cronaflex base maps compiled by the Cartography Section of the Ontario Division of Lands. The cronaflex base maps were derived from the Forest Resources Inventory maps of the Silviculture Section of the Ontario Division of Forests.

ACKNOWLEDGMENTS

During the field work the author was assisted by D. Beauchamp, senior assistant, and L.M. Kovacs, J.R. Foster and P. Los, junior assistants. Their help in carrying out the mapping project is greatly appreciated. Mr. L.M. Kovacs made a special study of northwesterly trending diabase dikes for a Bachelor's Thesis at the University of Windsor.

The author wishes to thank Mr. Howard Lovell, Resident Geologist for the Ministry of Natural Resources at Kirkland Lake, for valuable help and discussions during the field season, and Mr. and Mrs. G. Cruickshank for their help and many courtesies during the mapping project.

GENERAL GEOLOGY

Geological Summary

The lithological units indicated on the map face are listed in Table 1 in order of decreasing age. They belong to the Early and Middle Precambrian and the Cenozoic.

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR NATAL AND KNIGHT TOWNSHIPS

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Sand, gravel, swamp and stream deposits

Unconformity

PRECAMBRIAN

MIDDLE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (NIPISSING-TYPE)

Diabase, leucodibase

Intrusive Contact

HURONIAN SUPERGROUP

COBALT GROUP

GOWGANDA FORMATION

Orthoconglomerate, paraconglomerate, arenite, wacke, siltstone, argillite, siltstone-mudstone, slate, gravelly arenite.

Unconformity

EARLY PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (MATACHEWAN-TYPE)

Diabase, porphyritic diabase, leucodibase, and granophyric diabase, as dikes.

Intrusive Contact

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Hornblende-biotite granitoid rocks, pink and grey; feldspar-hornblende granitoid porphyry; granitoid-basalt contact rock.

Intrusive Contact

METAVOLCANICS AND METASEDIMENTS

METASEDIMENTS

Chert, greywacke

ALKALIC METAVOLCANICS

Mafic and intermediate aphanitic and porphyritic flows; tuff, lapilli tuff and tuff-breccia

SUBALKALIC METAVOLCANICS

THOLEIITIC AND CALC-ALKALIC METAVOLCANICS

Mafic, intermediate, and felsic aphanitic, porphyritic, pillowed, amygdaloidal, coarse-grained and variolitic flows; tuff, lapilli tuff and tuff-breccia; amphibolite.

KOMATIITIC METAVOLCANICS

Serpentinized dunitic and peridotitic komatiites, basaltic komatiite; serpentinite, serpentine-carbonate breccia, green carbonate rock, lapilli tuff, hornblende wehrlite.

EARLY PRECAMBRIAN

The Early Precambrian rocks are exposed in northeastern and southwestern Knight Township and throughout Natal Township. They comprise metavolcanics and associated intrusive rocks, metasediments, intrusive felsic to intermediate plutonic rocks, and intrusive diabase dikes. Chemically, the metavolcanics are subalkalic and alkalic; peralkalic rocks were not encountered. Mineralogical alteration of the plutonic rocks makes it difficult to determine their original nature but it is believed that they are calc-alkalic granite, granodiorite

NATAL AND KNIGHT TOWNSHIPS

and diorite. The diabase dikes are tholeiitic quartz diabase though quartz is not visible megascopically.

Komatiitic volcanic rocks of the subalkalic suite occur in southwestern Knight Township. These comprise dunitic and peridotitic komatiite and their metasomatized equivalents. The rocks are mineralogically and chemically altered and cannot be accurately classified on the basis of their major element chemistry. However, field and microscopic evidence satisfy all the three criteria suggested for their field recognition, as proposed by Naldrett and Cabri (1976, p.1138), and on this basis they are classified as komatiite by the author. This interpretation is confirmed by (1) the occurrence of fragmental units, one of which is known locally as 'deckerite' and is regarded by the author as an ultramafic lapilli tuff, (2) the presence of olivine-rich rocks (the olivine occurring as partially and wholly replaced relicts), and (3) the occurrence of spinifex texture.

The remaining subalkalic rocks are tholeiitic and calc-alkalic, and consist of felsic, intermediate, and mafic units. The tholeiitic and calc-alkalic rocks have not been shown separately on the map. Both flows and pyroclastics are present, but pyroclastics are rare amongst the mafic rock types. The mafic and intermediate flows were extruded subaqueously, as they show pillowed structures. Pyroclastic rocks reach their best development as intermediate rocks and occur in the northwestern half of Natal Township. They are mainly tuffs and crystal tuffs that were deposited subaqueously. Well-preserved sedimentary structures comprising graded bedding, load casting and ball and flame structures are common. Some of these rock units grade upwards into a green cherty rock which is rhyolitic in composition.

The alkalic suite includes rocks of mafic and intermediate composition and these belong chemically to both the potassic and sodic series. They are mauve, dark red, and light pink rocks, and are best developed in southeastern Natal Township. Both flows and pyroclastic rocks occur.

Metasediments comprise greywacke and chert. They are very rare and are mainly intercalated with the tuffs in south-central and southwestern Natal Township.

The metavolcanics and metasediments are folded about a synclinal axis which trends N50-60W through central Natal Township. The plunge is calculated to be about 20 degrees northwesterly on the basis of a stereographic plot of the measurements made on the dip and strike of the beds in the northwestern part of Natal Township. No drag folds have been observed. The synclinal axis is sinuous and swings northwards in the northwestern part of Natal Township. On the basis of this structure, the rocks in Knight and northeastern Natal Townships occur on the northeastern limb of the syncline and the rocks in southwestern Natal Township occur on the southwestern limb. Stratigraphically, tholeiitic and calc-alkalic metavolcanics in the northeastern part of Knight Township form the lowest exposed rocks in the map-area. These are succeeded by komatiitic ultramafic and mafic rocks which are in turn overlain by interlayered calc-alkalic and alkalic volcanic rocks. All the rocks have been affected by regional metamorphism under greenschist facies conditions.

The felsic to intermediate plutonic rocks occur mainly as two masses: the Lafricain Pluton located in northeastern Knight Township and the Milly Creek Pluton located at the middle part of the southern boundary of Knight Township. The Lafricain Pluton is believed by the author to be the southwestern end of the Round Lake Batholith. No plutonic rocks of any kind occur in Natal Township. Owing to the almost complete alteration of the feldspars the rocks cannot be classified modally. Two common types occur: a pink to brown, equigranular to porphyritic rock; and a grey, equigranular, hornblende-feldspar rock. Massive rocks are more common than porphyritic types. It is believed that the pink to brown rocks are granitic and the grey rocks are granodioritic and dioritic. The pink to brown granitic rocks are most common in the Lafricain Pluton, whereas the grey granodioritic-dioritic rocks predominate in the Milly Creek Pluton. Both plutons are elongated in the direction of the regional trend of the metavolcanic metasedimentary rocks, that is, northwestwards. Also, the plutons extend beyond the limits of the map-area in their respective areas of outcrop.

The diabase dikes form part of a northwesterly trending regional dike swarm. They range in width from 15 to 60 m, and consist of dark green and black, fine- to medium-grained diabase. They are invariably quartz diabases as observed under the microscope although quartz is not visible in hand specimen. The rocks are always magnetic, and in some cases sufficiently so as to affect a compass. The rocks occur throughout the map-area and cut the metavolcanic-metasedimentary and granitoid rocks. They are thus the latest of the Early Precambrian rocks.

MIDDLE PRECAMBRIAN

Middle Precambrian rocks comprise clastic sedimentary rocks of the Gowganda Formation of the Huronian Cobalt Group, and intrusive diabase of Nipissing type.

The Gowganda Formation comprises conglomerate, sandstone, siltstone and argillite, which occur in the northeastern and east-central parts of Natal Township and the northern, central, and southeastern parts of Knight Township. In Knight Township they are much more extensively developed. Conglomerates are better developed in Natal Township, and the rocks become progressively finer towards the eastern part of the map-area. Abundant primary sedimentary features and structures were observed in Knight Township. These features indicate that the rocks trend northwards, but form a gently curving, concave-eastwards structure. Dips range from 15 to 30 degrees eastwards on average, but in the neighbourhood of faults, tight folding and steep dips were observed. The rocks young towards the east. In Natal Township structural data are rare, but where obtained, as in the north-eastern part of the township, the rocks dip northwest. If this is characteristic of the rocks in Natal Township, then the rocks are folded into a broad anticlinal arch, the axis of which trends approximately northwards. In the neighbourhood of faults the rocks are locally foliated due to dynamic metamorphism.

Igneous rocks of the Middle Precambrian are represented by diabase. These mafic rocks are dark green or mottled black and grey, massive rocks, which vary from fine to coarse grained. Medium-grained rocks are the commonest type. The rocks occur mainly as an arcuate, gently concave-east, north-trending sill intrusive into the Huronian sedimentary rocks in the east-central part of Knight Township. The sill dips eastwards at approximately 20 degrees. The same rock-type also forms small northerly trending sills in eastern Knight Township and northeasterly trending dikes in the southeastern part of the township. Small, unconnected masses of diabase overlie Early Precambrian metavolcanics in north-eastern Knight Township and may represent erosional remnants of a former flat-lying sill.

CENOZOIC

Sand, gravel and alluvium comprise the Pleistocene and Recent deposits of the Cenozoic in the map-area. They occur as blanket deposits and as eskers. The blanket deposits occur in southwestern Natal Township and central and north-central Knight Township. In the latter area, extensive swamp deposits consist of muskeg and fine yellow silty deposits. Coarse sand and gravel form eskers aligned north-south in southwestern and south-central Natal Township, and in southeastern and southwestern Knight Township. The longest and highest esker is in southeastern Knight Township; it is about 9.7 km long.

NATAL AND KNIGHT TOWNSHIPS

Petrography and Chemistry

EARLY PRECAMBRIAN

Metavolcanics

The metavolcanics, which belong to the subalkalic and alkalic suites, are bluish-black, various shades of green and grey, mauve, red, or pink, aphanitic, porphyritic and pillowed rocks. They have been chemically classified according to the system of Irvine and Baragar (1971) but in separating these two groups the dividing line of MacDonald (1966) has been used, as this dividing line gives a more consistent classification of rocks of similar lithological and petrographic characteristics.

Figures 2 is an alkalis-silica plot of all analyses of metavolcanic samples from the map-area, and shows the division between alkalic and subalkalic rocks. Figure 3 shows the equivalent division on the $Or'Ne'Q'$ plot. Figure 4 is a cation plot (Jensen 1976), used

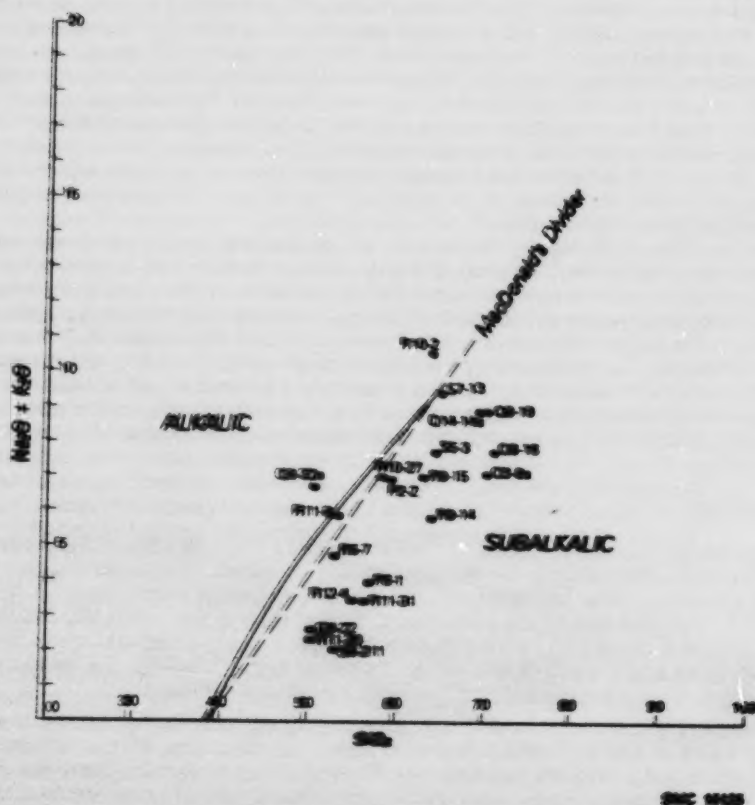


Figure 2. Alkali-silica plots of selected metavolcanics from Natal and Knight Townships. Plots in weight percent. Solid line from Irvine and Baragar (1971); dashed line from MacDonald (1966).

here for the komatiitic rocks. Figure 5 is the AFM diagram used to separate the tholeiitic from the calc-alkalic suites. Figure 6 is a plot of mafic tholeiitic and calc-alkalic rocks only, used for the same purpose, as such a diagram is considered (Irvine and Baragar 1971) best suited to separate mafic tholeiitic from mafic calc-alkalic rocks. Figure 7 shows the subdivision of the subalkalic rocks into basalt, andesite, dacite, and rhyolite. Figure 8 is a subdivision of the alkalic rocks into sodic and potassic series, and Figures 9 and 10 show the classification of these two series into the various rock-types as suggested by Irvine and Baragar (1971).

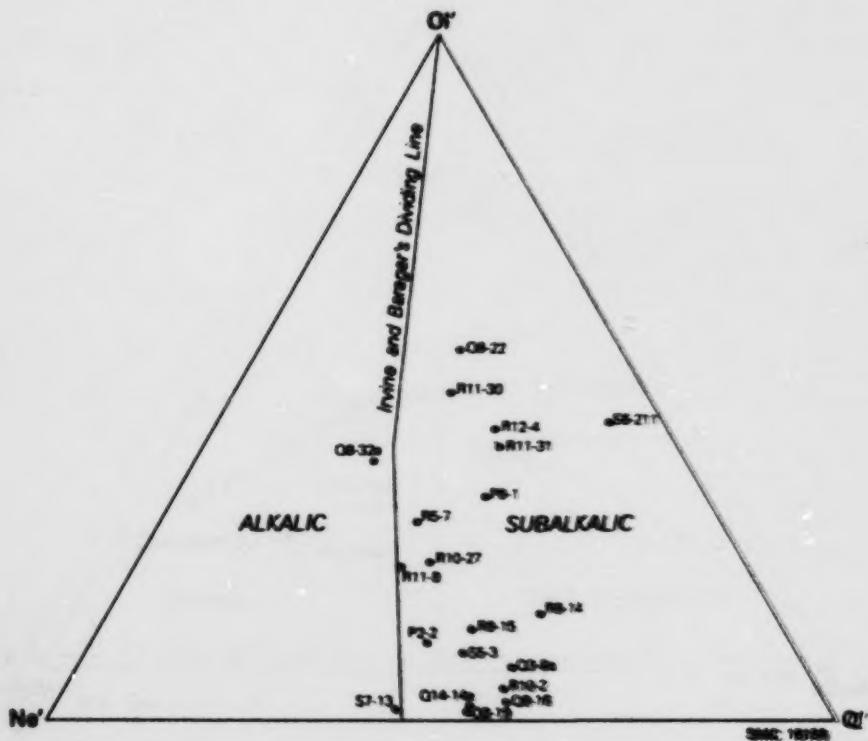


Figure 3. $Ol^* - Na^* - Q^*$ projection of selected metavolcanics from Natal and Knight Townships. Plots in percent cation equivalents based on the cation norm. Ol^* = normative olivine + $\frac{1}{2}$ (enstatite + ferrocillite); Na^* = normative nepheline + $\frac{1}{2}$ albite; Q^* = normative quartz + $\frac{1}{2}$ albite + $\frac{1}{2}$ (enstatite + ferrocillite).

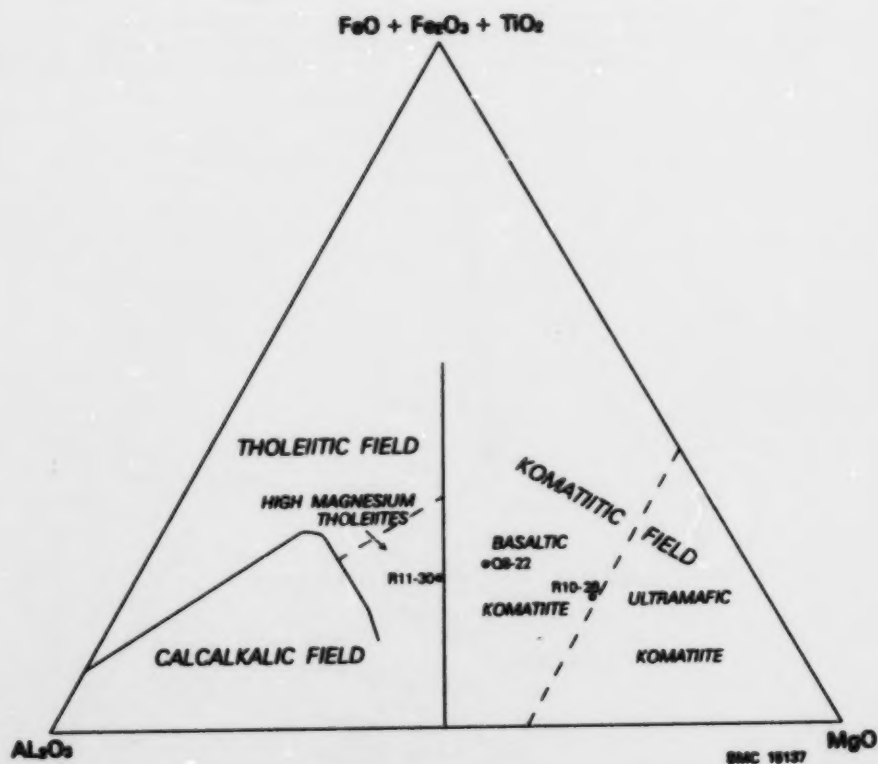


Figure 4. FeO + Fe₂O₃ + TiO₂ - Al₂O₃ - MgO cation plot (after Jensen 1976) of selected komatiitic metavolcanics.

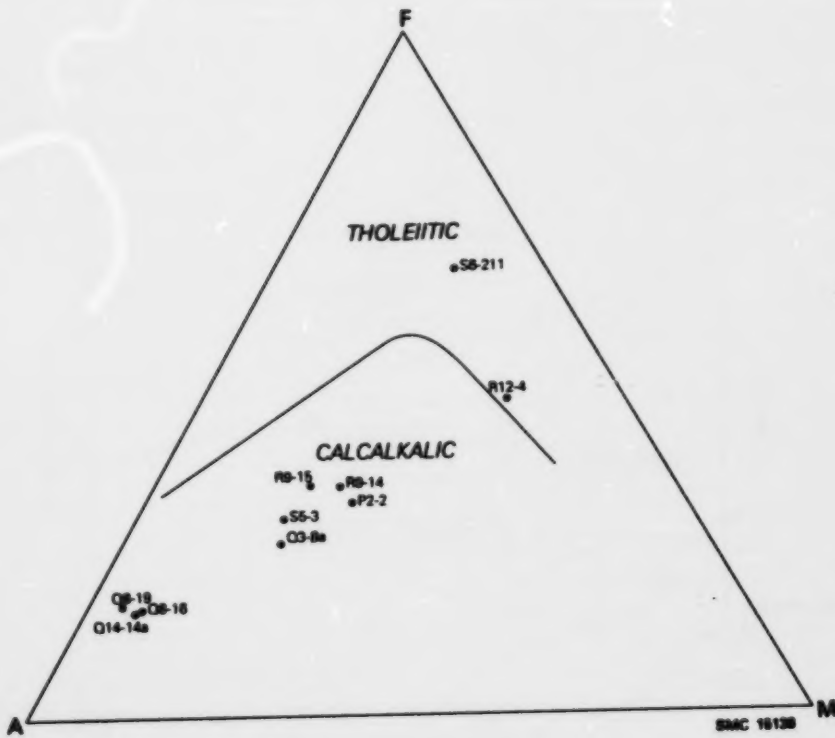


Figure 5. AFM plots of selected tholeiitic and calc-alkalic metavolcanics from Netai and Knight Townships. A = $\text{Na}_2\text{O} + \text{K}_2\text{O}$; F = $\text{FeO} + 0.8998 \text{ Fe}_2\text{O}_3$; M = MgO , all in weight percent.

NATAL AND KNIGHT TOWNSHIPS

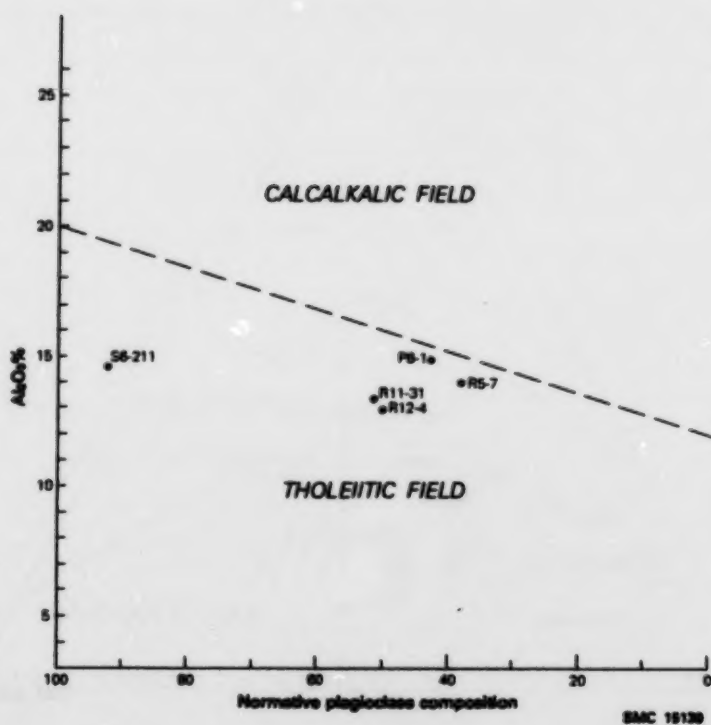


Figure 6. Plot of Al_2O_3 (weight percent) vs normative plagioclase composition of selected tholeiitic and calc-alkalic metavolcanics from Natal and Knight Townships.

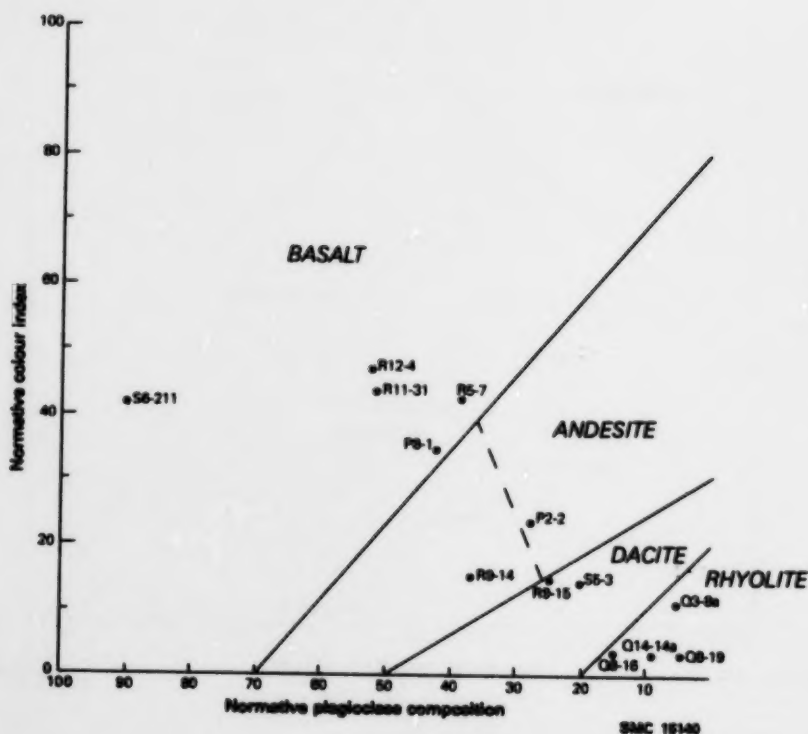


Figure 7. Plot of normative colour index vs normative plagioclase composition of selected tholeiitic and calc-alkalic metavolcanics from Natal and Knight Townships.

NATAL AND KNIGHT TOWNSHIPS

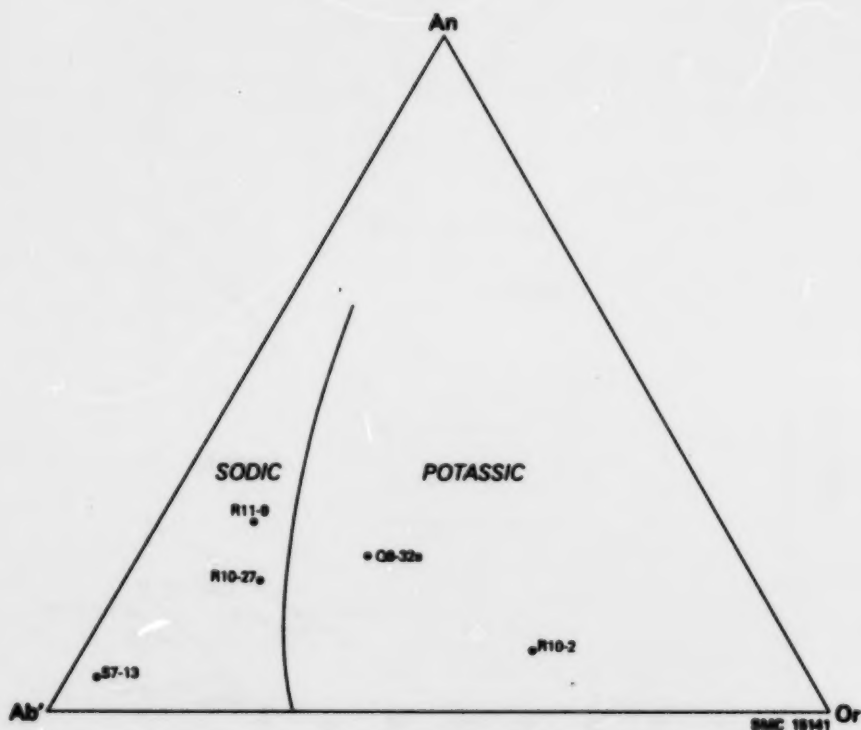


Figure 8. An-Ab'-Or projection of selected alkalic metavolcanics from Natal and Knight Townships. Plots are in percent cation equivalents. An = normative anorthite; Ab' = normative albite + ½ nepheline; Or = normative orthoclase.

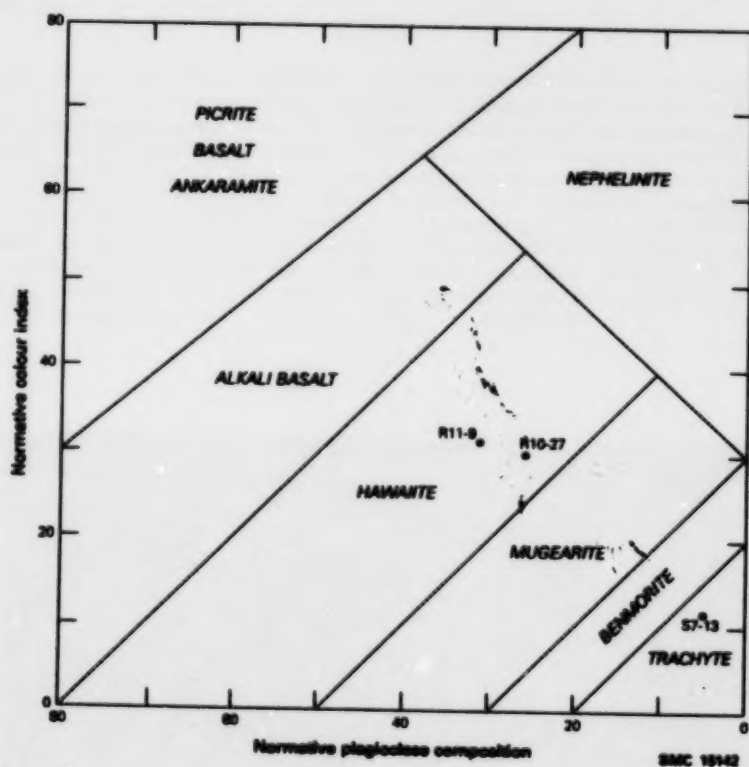


Figure 9. Plot of normative colour index vs normative plagioclase composition for selected sodic, alkalic metavolcanics from Natal and Knight Townships. Plots in percent cation equivalents.

NATAL AND KNIGHT TOWNSHIPS

Rock classification according to the Irvine and Baragar system varies according to the diagram used where alternate diagrams for discrimination are available, and some names obtained are not always consistent with observed lithological characteristics or the chemical characteristics given in Appendix II of the Irvine and Baragar (1971) classification scheme. This was found by the author to be due to rock alteration in some cases, or to the use of the Irvine and Baragar (1971) dividing line rather than the MacDonald (1968) dividing line to separate subalkalic from alkalic rocks on the silica-alkalies plot. These are discussed below under the specific rock-types.

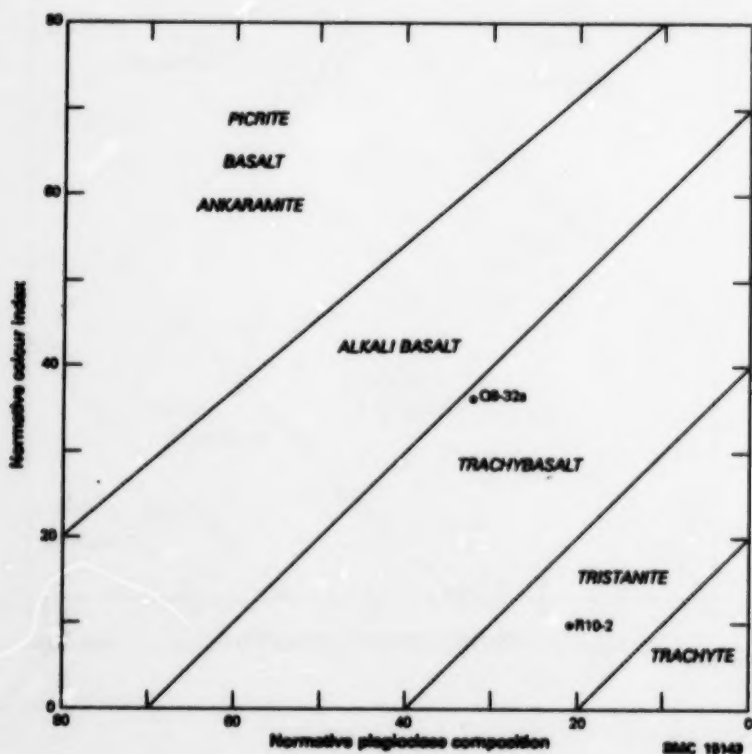


Figure 10. Plot of normative colour index vs normative plagioclase composition for selected potassic, alkalic metavolcanics from Natal and Knight Townships. Plots in percent cation equivalents.

SUBALKALIC METAVOLCANICS

Komatitic Metavolcanics

ULTRAMAFIC KOMATIITES. Ultramafic komatiites are predominantly aphanitic rocks, which are bluish-black, dark green, light green and grey on the fresh surface. Those with a bluish-black fresh surface weather either greenish-grey or reddish-brown. They are best exposed in southwestern Knight Township between Arthur and Pigeon Lakes, where they are interlayered with mafic metavolcanics. Lighter shades of green occur where the rocks are sheared or are cut by irregular veins of quartz and pink or white calcite. The lighter colour is due to carbonatization, the ultimate effect of which is to produce a pale 'green-carbonate' rock.

Lavas. Flows of ultramafic komatiite are fine-grained, bluish-black on the fresh surface, and show a faint colour banding about 1 mm thick in shades of green and dark green in outcrop. Spinifex texture occurs in varying degrees of coarseness, and is exposed in southwestern Knight Township and southeastern Netai Township. These rocks, interlayered with mafic metavolcanics, are particularly well developed in an area 0.4 km north-northeast of the northern end of Arthur Lake in Knight Township. The texture and mineralogy of the rocks compare with quenched ultramafic rocks described by Viljoen and Viljoen (1969), Nesbitt (1971), and Pyke *et al.* (1973), and the author considers them to be part of a typical komatiitic series (Viljoen and Viljoen 1969; Naldrett and Cabri 1976, p.1133-1136), although, because of chemical alteration, they do not plot in the ultramafic field on the Jensen (1976) cation diagram.



OGS 10488

Photo 1. Photomicrograph of an ultramafic komatiite showing altered olivine phenocrysts. Crossed nicols. Specimen R11-42.

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One of these rocks shows, on a polished surface, euhedral, subhedral and sub-rounded individual and coalescing mafic grains set in a black, aphanitic, matrix. The grains are 1-3 mm across, and their shape indicates that they are olivine crystals. Owing to the alteration, the specific gravity is 2.66. The microtexture of this rock is shown in Photo 1. In thin section the rock is seen to be composed of serpentinized olivine grains as indicated by the shape of the crystals. The serpentine mineral is mainly antigorite, with lesser chrysotile along fractures. No relict pyroxene can be seen. The outlines of the olivines are marked mainly by dusky brownish tremolite, but in some places by magnetite. Pale greenish chlorite forms the interstitial material about the olivine grains, and it contains minor amounts of talc. Opaque minerals consist mainly of magnetite and minor chromite. Magnetite occurs in two forms: spongy arborescent streaks outlining and filling cracks in olivine pseudomorphs, and square, rectangular and rhombic grains. In some olivine pseudomorphs almost the entire grain is replaced by fine granular magnetite.

Another is grey and brecciated, consisting of subrounded and rounded coalescing fragments, 20-50 mm across, of aphanitic and fine grained material. The fine-grained fragments, which show microspinel texture, are of the same composition. The microtexture of the rock is shown in Photo 2. In thin section the rock shows acicular euhedral and subhedral criss-cross grains of carbonatized relict olivine in a very fine-grained, brownish, divitrified, partly carbonatized and chloritized glass matrix, containing irregular areas of microgranular quartz. Opaque grains consist of magnetite and pyrite. The chemical analyses, unadjusted and adjusted for volatiles, and cation percentages of this rock (sample R9-20) are given in Tables 2, 3 and 4, and the equivalent norm in Table 5. The chromium content of the rock is 80 ppm, the nickel content 130 ppm.

Another example of this rock type is aphanitic and green in colour. It shows well developed spinifex texture on a mesoscopic scale, especially well seen on the fresh surface;



OGS 10497

Photo 2. Photomicrograph of ultramafic komatiite showing spinifex texture consisting of acicular criss-cross olivine. Crossed nicols. Specimen R9-20.

TABLE 2. CHEMICAL ANALYSES* (WEIGHT PERCENT) AND SPECIFIC GRAVITY OF SELECTED KOMATIITIC METAVOLCANICS.

Specimen	1 R9-20	2 Q9-12a	3 R10-28	4 R11-30	5 Q9-22
SiO ₂	48.1	51.3	44.7	50.40	46.70
Al ₂ O ₃	12.0	10.8	9.48	13.60	12.10
Fe ₂ O ₃	1.22	1.42	1.21	0.51	2.82
FeO	9.34	7.43	9.06	9.06	8.80
MgO	7.17	6.75	20.1	10.40	12.70
CaO	8.30	9.02	9.51	11.50	6.14
Na ₂ O	0.35	2.05	0.49	2.10	2.34
K ₂ O	1.13	0.17	0.04	0.21	0.06
TiO ₂	0.82	0.58	0.72	0.88	0.67
P ₂ O ₅	0.06	0.05	0.03	0.06	0.06
S	0.1	0.06	0.09	0.09	0.01
MnO	0.20	0.22	0.25	0.20	0.18
CO ₂	5.56	6.30	0.15	0.18	2.60
H ₂ O ⁺	4.80	3.46	3.68	0.91	4.81
H ₂ O ⁻	0.66	0.38	0.97	0.41	0.79
TOTAL	99.8	100.0	100.5	100.5	100.8
SPEC. GR.	2.74	2.73	3.01	2.99	2.79

SPECIMENS:

- 1) Komatiite (peridotitic, spinifex-textured), altered, 200 m NNE of northern end of Arthur Lake, west-central boundary of Knight Township.
- 2) Komatiite (peridotitic, spinifex-textured), altered, 400 m W of the west shore of the middle part of Pigeon Lake, western Knight Township.
- 3) Komatiite (peridotitic, spinifex-textured), 1200 m NE of northern end of Arthur Lake, west-central boundary of Knight Township.
- 4) Komatiite, basaltic, dark green; from outcrop on northwesterly projecting peninsula at southern end of Pigeon Lake, southwestern Knight Township.
- 5) Komatiite, basaltic, dark green; from outcrop about 1.6 km west of central part of Pigeon Lake, northwestern Knight Township.

*Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

TABLE 3. CHEMICAL ANALYSES (WEIGHT PERCENT) OF SELECTED KOMATIITIC METAVOLCANICS RECALCULATED TO A WATER-AND-CARBON DIOXIDE-FREE BASIS.

Specimen	1 R9-20	2 Q9-12a	3 R10-28	4 R11-30	5 Q9-22
SiO ₂	54.20	57.10	46.70	50.90	50.5
Al ₂ O ₃	13.50	12.00	9.91	13.70	13.1
Fe ₂ O ₃	1.37	1.58	1.26	0.52	2.35
FeO	10.52	8.27	9.49	9.17	10.14
MgO	8.06	7.51	21.00	10.50	13.7
CaO	9.35	10.04	9.94	11.60	6.64
Na ₂ O	0.39	2.28	0.51	2.12	2.53
K ₂ O	1.27	0.19	0.04	0.21	0.06
TiO ₂	0.92	0.65	0.75	0.89	0.72
P ₂ O ₅	0.07	0.06	0.03	0.06	0.06
S	0.12	0.09	0.09	0.09	0.00
MnO	0.23	0.24	0.26	0.20	0.19
TOTAL	100.02	100.01	99.98	99.96	99.99

SPECIMENS: See Table 2.

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TABLE 4. CATION PERCENTAGES OF SELECTED KOMATIITIC METAVOLCANICS.

Specimen	1 R9-20	2 Q8-12a	3 R10-28	4 R11-30	5 Q8-22
Si ⁴⁺	51.30	53.40	42.00	46.80	46.10
Al ³⁺	15.10	13.30	10.49	14.90	14.10
Fe ³⁺	0.98	1.11	0.86	0.35	1.61
Fe ²⁺	8.52	6.66	7.33	7.21	7.90
Mg ²⁺	11.40	10.47	28.10	14.40	18.70
Ca ²⁺	9.49	10.06	9.57	11.40	6.50
Na ⁺	0.72	4.14	0.89	3.78	4.48
K ⁺	1.54	0.23	0.05	0.25	0.08
Ti ⁴⁺	0.66	0.45	0.51	0.61	0.50
P ⁵⁺	0.05	0.04	0.02	0.05	0.05
S	0.22	0.16	0.16	0.16	0.00
TOTAL	99.98	100.02	99.98	99.91	100.02

SPECIMENS: See Table 2.

*Fe²⁺ includes Mn²⁺

TABLE 5. EQUIVALENT NORM, COLOUR INDEX, AND NORMATIVE PLAGIOCLASE COMPOSITION OF SELECTED KOMATIITIC METAVOLCANICS.

Specimen	1 R9-20	2 Q8-12a	3 R10-28	4 R11-30	5 Q8-22
Quartz	10.17	9.92	0.00	0.00	0.00
Corundum	0.00	0.00	0.00	0.00	0.00
Acmite	0.00	0.00	0.00	0.00	0.00
Orthoclase	7.70	1.13	0.24	1.25	0.38
Albite	3.62	20.69	4.46	18.92	22.40
Anorthite	32.07	22.23	23.89	27.16	23.82
Leucite	0.00	0.00	0.00	0.00	0.00
Nepheline	0.00	0.00	0.00	0.00	0.00
Kaliophilite	0.00	0.00	0.00	0.00	0.00
Diopside	7.34	14.54	15.56	16.56	4.87
Hedenbergite	4.60	7.63	3.45	7.20	1.72
Enstatite	19.14	13.68	17.33	12.91	23.07
Ferrosilite	12.00	7.18	3.84	5.61	8.14
Forsterite	0.00	0.00	23.37	5.72	8.90
Fayalite	0.00	0.00	5.18	2.49	3.14
Hematite	0.00	0.00	0.00	0.00	0.00
Magnetite	1.47	1.67	1.28	0.54	2.42
Ilmenite	1.32	0.91	1.02	1.23	1.00
Apatite	0.15	0.12	0.06	0.13	0.13
Pyrrhotite	0.44	0.31	0.32	0.31	0.00
TOTAL	100.02	100.01	100.00	100.03	99.99
Equivalent colour index	45.85	45.61	71.03	52.24	53.27
Normative Plagioclase % An	Bytownite 89.86	Labradorite 51.79	Bytownite 84.26	Labradorite 58.95	Labradorite 51.54

SPECIMENS: See Table 2.

acicular, parallel, radiating and intersecting black laths, 0.5 mm wide and up to 30 mm long, enclose polygonal areas containing similar, but narrower (0.25 mm) and shorter (3-6 mm) laths. The microtexture of this rock is shown in Photo 3. Randomly oriented, acicular, chloritized and carbonatized pseudomorphs of skeletal olivine enclosing similar but narrower, parallel, stumpy or radiating altered olivine, are set in a very fine-grained brownish chloritized and carbonatized matrix regarded as altered devitrified glass. Square, triangular and polygonal grains of chromite, and smaller grains of pyrite and magnetite occur. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample Q8-12a) are given in Tables 2, 3 and 4 respectively, and the equivalent norm in Table 5. The rock is regarded as a quenched peridotite by the author by analogy with the other rocks. The chromium content of the rock is 1060 ppm, the nickel content 400 ppm.

The fourth example which, however, shows quench texture only in thin section, is a fine-grained, dark-green rock. The microtexture consists of acicular randomly oriented laths of chlorite (probably after olivine) enclosing triangular and polygonal interstitial fine-grained, radiating, sheaf-like, and lamellar tremolite. Square and rectangular grains of chromite, pyrite and leucosene as irregular grains are scattered through the section. The unadjusted and adjusted chemical analyses and cation percentages of the rock (sample R10-28) are given in Tables 2, 3 and 4, and the equivalent norm in Table 5. The chromium content of the rock is 1960 ppm and the nickel content is 520 ppm. These amounts are in keeping with the ultramafic character of this rock. This rock is plotted on the Jensen (1976) cation plot (Figure 4) and it falls just within the basaltic komatiite field at its boundary with the ultramafic komatiite field. The MgO content of the two rocks described above (R9-20 and Q8-12a) is low because of losses during alteration, as compared with typical komatiites. The nickel and chromium contents of these rocks are, however, within and beyond the range for Yakabindie basaltic komatiites given by Naldrett and Cabri (1976, p.1135) (the Cr



QGS 10486

Photo 3. Photomicrograph of interblade acicular olivine from quenched ultramafic komatiite. Crossed nicols. Specimen Q8-12a.

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values were converted from the Cr_2O_3 values given) of 100-181 ppm for Ni (average 146 ppm), and 144-547 ppm Cr (average 285 ppm).

Variolitic, serpentinitized, peridotitic komatiite occurs in the map-area, but is not a common rock type. It consists of pale purple, circular and elliptical varioles from 2 to 6 mm in diameter, set in dark greenish black, fine-grained, ultramafic material showing spinifex texture. Some of the varioles coalesce to form irregular variolitic areas up to 20 mm across. The microtexture of the rock is shown in Photo 4 and this particular sample has a specific gravity of 2.97. Thin section study shows the varioles to consist of parallel and radiating acicular laths of serpentine and clinopyroxene set in a very fine-grained, brownish matrix believed to represent devitrified ultramafic glass. This matrix also contains curving and plumose clinopyroxene surrounded by pale green chlorite. Some of the radiating clinopyroxene radiates from crescentic clinopyroxene structures. Sparse relict grains of serpentinized olivine occur in the matrix of the varioles. The intervariole material is similar in composition and texture to that of the varioles except that it is lighter in colour. Serpentinized, glomeroporphyritic olivine grains also occur in the intervariole material. Opaque minerals consist of magnetite and pyrite. The texture of the variolitic rock is similar to that of grey, aphanitic peridotites described above, all of which show quench textures.

An exposure of hornblende wehrliite occurs in the map-area, about 0.4 km northeast of Pigeon Lake. It is a dark, heavy, coarse-grained rock with lustrous cleavage plates of hornblende 2 by 3 mm across. In thin section the rock shows hypidiomorphic granular texture, consisting of subhedral and anhedral poikilitic, pleochroic, brown and bleached hornblende enclosing subhedral and rounded grains of serpentinized olivine, and colourless augite altering to brown hornblende. Aggregate areas consisting of calcite, talc, chlorite, and serpentine form pseudomorphs apparently after hornblende. Such aggregates also occur interstitially. Opaque minerals consist of irregularly shaped grains of pyrite, leucosene, and minor chromite. This rock may be intrusive.



OGS 10489

Photo 4. Photomicrograph of inter-variole matrix of variolitic peridotitic komatiite showing spinifex texture and altered olivine phenocryst. Crossed nicols. Specimen R11-38.

Pyroclastic Rocks. A specimen of 'deckerite' (a local name) was obtained by the author from Mr. A. Decker, who took the sample from an outcrop on the northwesterly projecting peninsula on the northeastern shore of Arthur Lake, at the west-central boundary of Knight Township. An exposure of similar rock was located by the author at Ribble Rapids, West Montreal River in southeastern Natal Township. The 'deckerite' consists of angular, subangular and subrounded grey, yellowish-green and greenish-grey aphanitic fragments varying from 8 to 15 mm across, set in a dark greyish-black, fine-grained matrix. The yellowish green fragments have the same colour and texture as the green carbonates described below. Grains of pyrite ranging from 0.5 to 1 mm are scattered through the matrix and some also coats the fragments. In thin section the fragments are of various kinds: some show acicular and lath shaped, cloudy brownish-grey polarizing crystals containing irregular, clear, gray polarizing patches of serpentine after olivine in an aphanitic, brownish, carbonate matrix containing clear radiating, plumose and chloritized olivine grains, the whole showing characteristic quench texture; some consist only of skeletal, acicular, grey-polarizing, radiating and sheaf-like feldspar and irregular patches of pale green chlorite; some are chips of secondary, aggregate-polarizing quartz; some are yellowish-brown, composite, microspherulitic aggregates of chlorite and yellow serpentine in an aphanitic brownish matrix containing patches of secondary silica; and others are serpentinized and carbonatized euhedral olivine crystals set in a chlorite matrix containing grains of chromite. Some of the grains are rimmed with irregular black opaque material, some of which is leucocoxene. Amygdules of carbonate and secondary silica also occur. Opaque minerals consist of polygonal, triangular and rhombic grains of chromite, irregular ovoid grains of pyrite, and mossy black irregular areas coating grains which may be magnetite. As this fragmental rock clearly consists of fragments of different rock types, some of which are evidently the quench peridotites, the rock is classed by the author as ultramafic lapilli tuff rather than ultramafic tectonic breccia.

BASALTIC KOMATIITE. Basaltic komatiite is dark green and aphanitic. An example of this rock type shows, in thin section, bladed, sheaf-like actinolite with ragged terminations and minor chloritized, relict, euhedral olivine, embedded in a fine-grained, granoblastic matrix of epidote and acicular altered feldspar in which small, irregular grains of pyrite are scattered. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample R11-30) are given in Tables 2, 3, and 4, and the equivalent norm is given in Table 5. The rock contains 10.50 weight percent MgO and 9.62 percent $\text{FeO}_{\text{total}}$ on a dry basis and plots just within the magnesian tholeiite field on the cation plot (Figure 4). Because of the MgO and FeO contents, the rock is considered to be a basaltic komatiite by the author, following Jensen (1978, p.13), although it contains more than 12 percent Al_2O_3 .

A coarse-grained facies shows well developed coarse, spinifex texture consisting of acicular crystals of dark green chlorite 50 mm long by 1 mm wide arranged in sheaf-like form. A thin section of this rock, cut at right angles to the elongate crystals shows bladed crystals of pale green chlorite altering to brownish calcite and epidote, and disoriented euhedral and subhedral albite (An_2), enclosing pale green, irregular, interstitial chlorite showing aggregate extinction and containing irregular spongy grains of sphene. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample Q8-22) are given in Tables 2, 3, and 4, and the equivalent norm in Table 5. This rock contains 13.7 weight percent MgO and 12.25 percent $\text{FeO}_{\text{total}}$ on a dry basis and plots in the basaltic komatiite field on the cation plot (Figure 4). The Al_2O_3 content is however greater than 12 percent.

The chromium content of the first rock (R11-30) is 560 ppm, and the nickel content is 170 ppm, and for the second rock (Q8-22) these values are 1160 and 300 ppm, respectively. These amounts exceed the range and average for tholeiites from the Yakkabindie area of Western Australia as given by Naldrett and Cabri (1978, p.1135) (the Cr values were derived from the Cr_2O_3 values given) of <7-230 ppm for Cr (average 94 ppm), and 25-127 ppm for Ni (average 76 ppm).

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CARBONATIZED KOMATIITE. Serpentinite-carbonate breccia though uncommon, is striking when seen at outcrop. It is well exposed on an island in Pigeon Lake 1.2 km north-northwest of Brush Lake. The entire unit as exposed consists of rounded, grey-green serpentinite fragments averaging 25 cm across in a white or pale buff carbonate matrix. No shearing was observed, and the brecciation and carbonatization seems to be a primary feature associated with autometamorphism of the rock.

Green carbonate is a yellowish-green rock which is associated with the ultramafic rocks at the eastern shore of Arthur Lake in southwestern Knight Township. When freshly broken the rock is green in colour but after exposure for some time the colour fades to a light yellow-green. The rock weathers to a dark brown, pitted, limonitic surface. Very often these carbonate rocks are criss-crossed by veins of quartz about 5 mm wide and narrow stringers of white carbonate. They are commonly associated with shearing, and it is believed by the author that these shear zones formed channel ways for hydrothermal solutions which converted the associated ultramafic rocks to green carbonate by carbon dioxide metasomatism (Turner and Verhoogen 1960, p.578-581). Mineralogical examination at the Geoscience Laboratories, Ontario Geological Survey, showed that the rock consists dominantly of dolomite with minor amounts of chlorite and quartz. Neither magnetite nor calcite was present. The texture of this rock is shown in Photo 5. The chlorite occurs mostly as discrete areas in the dolomite, and the shape of some of the chlorite areas, e.g. at the centre of the field, suggest that they are pseudomorphs after olivine. Grains of pyrite are scattered through the rock. The rock may originally have been dunitic in composition.

Some examples of this green carbonate show spherulites of lighter green carbonate 1 mm in diameter scattered through the rock and these may represent carbonatized variolitic peridotites.



OGS 10500

Photo 5. Photomicrograph of green carbonate rock showing relict chloritized olivine phenocryst in the centre of the photograph. Crossed nicols. Specimen R9-23.

Tholeiitic and Calc-Alkalic Metavolcanics**MAFIC THOLEIITIC AND CALC-ALKALIC METAVOLCANICS.**

Lavas. Mafic subalkalic lavas are tholeiitic or calc-alkalic, and are dark green, light grey or grey-green, aphanitic, fine-grained to medium-grained equigranular and porphyritic rocks. The tholeiitic and calc-alkalic varieties have not been separated on the map.

Pillowed, vesicular, amygdaloidal and variolitic lithostructures were observed and serve to indicate the extrusive nature of the rocks. Exposures were not sufficiently continuous to show the dimensions of individual flows. Where no evidence of intrusive contact was seen, coarse-grained facies were interpreted as interior parts of flows. For the most part the rocks are unfoliated, but in a few places in the aureole of the Lafricain Lake pluton in northeastern Knight Township, foliate and banded structures were observed. The mafic metavolcanics are almost entirely confined to the northeastern and southwestern parts of Knight Township but they are better exposed in the former area.

Aphanitic flows are the commonest types and are mainly dark green. Light grey or grey-green types occur occasionally and are brecciated locally.

An example of a dark green variety shows amphibole blades 3 mm long by 0.05 mm wide in hand specimen. In thin section the large, randomly oriented blades of actinolite have ragged terminations and enclose intergranular areas composed of small, sheaf-like and plumose ragged grains of actinolite; laths of randomly oriented, saussuritized plagioclase are surrounded by interstitial areas of pale green chlorite. Small irregular grains of leucoxene are scattered throughout the section, and a few triangular and rectangular grains of chromite are present. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample R11-31) are given in Tables 6, 7, and 8 respectively and the equivalent norm in Table 9. The rock is classified as a tholeiitic basalt by the method of Irvine and Baragar (1971) (Figures 6 and 7). The chromium content of this rock is 620 ppm. The nickel content is 270 ppm.

The light grey and grey-green rocks are not as widespread as the dark green types. One example of the grey-green type shows, in thin section, altered, euhedral, lath-shaped plagioclase (oligoclase An_{20}) with a moderately developed parallel orientation in a matrix of microgranular quartz, calcite and chlorite. The rock is crossed by narrow irregular veins of chlorite. Subrectangular, triangular, and irregular grains and streaks of leucoxene traverse the rock. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample P8-1) are given in Tables 6, 7, and 8 respectively and the equivalent norm in Table 9. The rock is classed as a tholeiitic basalt in the chemical classification of Irvine and Baragar (1971) (see Figures 6 and 7). The chromium content is 60 ppm, the nickel content 75 ppm.

Another example, and one which shows quench textures on the weathered surface, shows in thin section stumpy and lath-shaped euhedral phenocrysts of feldspar altered to carbonate and microgranular quartz, set in a very fine-grained, pale brownish microgranular matrix of quartz, chlorite, and sericite containing acicular disoriented skeletal feldspar. Traversing the thin section are irregular streaks of chlorite which are evidently the dark radiating streaks that define the quench texture. Opaque grains scattered through the rock are leucoxene. The unadjusted and adjusted chemical analyses and cation percentages of the rock (sample S6-211) are given in Tables 6, 7, and 8, and the equivalent norm in Table 9. The rock is classed as a tholeiitic basalt in the chemical classification of Irvine and Baragar (1971) (see Figures 6 and 7). The chromium content of the rock is 260 ppm, the nickel content 110 ppm.

Skeletal plagioclase, some of which shows swallow-tail terminations, in the light grey and grey-green rocks described above is evidence that the rocks were very quickly cooled.

Coarse-grained mafic units are regarded as interior parts of flows. An example of one of these is black in hand specimen and shows acicular crystals of amphibole. The thin section shows bladed, sheaf-like and plumose, green, patchily chloritized actinolite with rag-

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TABLE 6. CHEMICAL ANALYSES* (WEIGHT PERCENT) AND SPECIFIC GRAVITY OF SELECTED THOLEIITIC AND CALC-ALKALIC, MAFIC METAVOLCANICS.

Specimen	1 R11-31	2 PB-1	3 98-211	4 R12-4	5 PB-7
SiO ₂	55.10	52.40	47.80	54.10	51.7
Al ₂ O ₃	13.20	13.70	13.10	12.90	13.7
Fe ₂ O ₃	0.26	0.36	0.16	0.85	5.30
FeO	7.95	9.57	10.20	9.49	4.59
MgO	8.80	5.58	3.72	8.80	7.37
CaO	7.52	5.05	10.80	7.48	9.04
Na ₂ O	2.32	3.29	0.35	2.24	3.35
K ₂ O	1.06	0.36	1.52	1.11	1.26
TiO ₂	0.76	1.27	1.20	0.91	1.10
P ₂ O ₅	0.05	0.10	0.30	0.07	0.07
S	0.01	0.12	0.04	0.05	0.00
MnO	0.16	0.16	0.25	0.22	0.13
CO ₂	0.12	2.50	7.36	0.28	0.30
H ₂ O ⁺	1.49	4.00	4.15	1.09	2.50
H ₂ O ⁻	0.37	0.60	0.55	0.63	0.20
TOTAL	100.2	99.1	101.5	100.2	100.6
SPEC. GR.	2.98	2.77	2.82	2.99	2.93

SPECIMENS:

- 1) Basalt (tholeiitic) dark green; from outcrop on northwesterly projecting peninsula at southern end of Pigeon Lake, southwestern Knight Township.
- 2) Basalt (tholeiitic) grey-green; from outcrop on southern shore of West Montreal River at its confluence with Pigeon Lake, northwestern Knight Township.
- 3) Basalt (tholeiitic) grey; from outcrop 1.6 km south of central Natal Lake in southeastern Knight Township west of West Montreal River.
- 4) Basalt (tholeiitic) dark green; from outcrop near eastern shore of southern end of Pigeon Lake, southwestern Knight Township.
- 5) Basalt (calc-alkalic) green; from outcrop about 1200 m north of midwestern end of Natal Lake, Natal Township.

*Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

TABLE 7. CHEMICAL ANALYSES (IN WEIGHT PERCENT) OF SELECTED THOLEIITIC AND CALC-ALKALIC MAFIC METAVOLCANIC RECALCULATED TO A WATER- AND CARBON DIOXIDE-FREE BASIS.

Specimen	1 R11-31	2 PB-1	3 98-211	4 R12-4	5 PB-7
SiO ₂	56.10	57.0	53.4	55.1	53.1
Al ₂ O ₃	13.40	14.9	14.6	13.1	14.1
Fe ₂ O ₃	1.28	0.39	0.18	0.87	2.67
FeO	8.09	10.40	11.4	9.66	7.21
MgO	8.96	6.07	4.16	8.96	7.57
CaO	7.66	5.49	12.1	7.62	9.29
Na ₂ O	2.36	3.58	0.39	2.28	3.44
K ₂ O	1.08	0.39	1.70	1.13	1.29
TiO ₂	0.77	1.38	1.34	0.93	1.13
P ₂ O ₅	0.05	0.11	0.34	0.07	0.07
S	0.01	0.13	0.04	0.05	0.00
MnO	0.16	0.17	0.28	0.22	0.13
TOTAL	99.92	100.01	99.93	100.02	100.00

SPECIMENS: See Table 6.

TABLE 8. CATION PERCENTAGES OF SELECTED THOLEIITIC AND CALC-ALKALIC MAFIC METAVOLCANICS.

Specimen	1 R11-31	2 PB-1	3 SS-211	4 R13-4	5 PB-7
Si ⁴⁺	52.00	53.00	51.40	51.10	49.00
Al ³⁺	14.70	16.30	16.60	14.40	15.30
Fe ³⁺	0.89	0.27	0.13	0.60	1.86
Fe ²⁺	6.40	8.24	9.40	7.68	5.67
Mg ²⁺	12.37	8.42	5.96	12.40	10.42
Ca ²⁺	7.60	5.48	12.40	7.58	9.19
Na ⁺	4.24	6.46	0.73	4.10	6.16
K ⁺	1.28	0.47	2.09	1.34	1.53
Ti ⁴⁺	0.54	0.97	0.97	0.65	0.78
P ⁵⁺	0.04	0.09	0.27	0.06	0.06
S	0.02	0.23	0.08	0.09	0.00
TOTAL	100.09	99.93	100.03	100.00	99.97

SPECIMENS: See Table 6.

*Fe²⁺ includes Mn²⁺**TABLE 9. EQUIVALENT NORM OF SELECTED THOLEIITIC AND CALC-ALKALIC MAFIC METAVOLCANICS.**

Specimen	1 R11-31	2 PB-1	3 SS-211	4 R13-4	5 PB-7
Quartz	5.54	6.91	9.81	3.82	0.00
Corundum	0.00	0.00	0.00	0.00	0.00
Acmite	0.00	0.00	0.00	0.00	0.00
Orthoclase	6.38	2.33	10.43	6.70	7.63
Albite	21.21	32.28	3.65	20.52	30.80
Anorthite	22.88	23.56	34.44	22.32	19.07
Leucite	0.00	0.00	0.00	0.00	0.00
Nepheline	0.00	0.00	0.00	0.00	0.00
Kaliophilite	0.00	0.00	0.00	0.00	0.00
Diopside	8.23	1.37	8.52	7.86	15.30
Hedenbergite	3.59	1.12	11.84	4.21	5.82
Enstatite	20.62	16.15	7.65	20.86	9.39
Ferrosilite	8.99	13.25	10.64	11.18	3.57
Forsterite	0.00	0.00	0.00	0.00	2.85
Fayalite	0.00	0.00	0.00	0.00	1.06
Magnetite	1.34	0.41	0.19	0.91	2.78
Ilmenite	1.08	1.93	1.94	1.29	1.57
Apatite	0.11	0.23	0.73	0.15	0.15
Pyrrhotite	0.04	0.46	0.16	0.18	0.00
TOTAL	99.99	100.00	100.00	100.00	100.01

SPECIMENS: See Table 6.

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ged terminations associated with subhedral laths of saussuritized plagioclase all of which enclose dark brownish altered feldspathic and chloritized areas. Opaque minerals consist of chalcopyrite and magnetite as anhedral, rectangular and irregular grains. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample R12-4) are given in Tables 6, 7, and 8 respectively. The equivalent norm is given in Table 9. The rock is not markedly altered chemically and in the chemical classification of Irvine and Baragar (1971) (see Figures 5, 6, and 7) it is classed as a tholeiitic basalt. It is thus similar to the dark green aphanitic rocks described above, and its composition is consistent with the mapping of these rocks as interior, coarse-grained facies of flows. The chromium content of this rock is 520 ppm, the nickel content 180 ppm. These values are of the same orders of magnitude as the quantities in the finer-grained equivalents.

Porphyritic rocks are uncommon and comprise pyroxene basalts. An example of this type is dark green in hand specimen, and contains phenocrysts of pyroxene measuring 3 mm long by 2 mm wide, set in a fine-grained matrix. The microtexture of this rock is shown in Photo 6. In thin section the rock is seen to consist of euhedral and subhedral phenocrysts of augite in a very fine-grained brown matrix of altered, randomly oriented feldspar containing irregular patches of pale green chlorite and epidote. Irregular grains of pyrite, and leucoxene after ilmenite, are scattered through the matrix. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample R5-7) are given in Tables 6, 7, and 8 respectively, and the equivalent norm in Table 9. In the chemical classification of Irvine and Baragar (1971) the rock is classed as tholeiitic basalt (see Figures 6 and 7). The chromium content of the rock is 360 ppm, the nickel content 170 ppm.

Variolitic flows are uncommon. In hand specimen the rocks are similar to the black tholeiitic basalts but contain varioles measuring from 2 mm to 4 mm across. These varioles stand out clearly on the weathered surface and show concentric weathering.



OGS 10801

Photo 6. Photomicrograph of calc-alkalic pyroxene basalt showing porphyritic texture. Crossed nicols. Specimen R5-7.

Pillowed flows are best exposed in northeastern Knight Township. These rocks are fine-grained, dark green in colour, and consist of pillows measuring 30-45 cm long by 15-30 cm wide. Chilled margins to the pillows are well developed and measure 3-4 cm thick.

Amygdaloidal basalts are uncommon. They are dark green or black fine-grained rocks containing 5 by 3 mm grey amygdules consisting of calcite. They do not contain phenocrysts.

Amphibolite consisting of banded and foliated derivatives of the mafic metavolcanics occur in the aureole of the Lafricain Lake granitoid pluton in northeastern Knight Township. The banded rock consists of alternating pink and dark green bands 2 mm wide. The pink bands are made up of quartz and saussuritized feldspar, and the dark green bands are of hornblende. The foliated rock consists of a granoblastic aggregate of green pleochroic hornblende, dusky epidotized feldspar, pale yellow epidote, and subhedral grains of pyrite. Some pyrite also occurs as elongated patches along the cleavage planes of the hornblende. These facts indicate that the amphibolite facies of regional metamorphism was attained in the aureole of the Lafricain pluton, but subsequently the rocks were affected by retrograde metamorphic effects.

Pyroclastic Rocks. Mafic pyroclastic rocks are represented by tufts and lapilli tufts, defined on the basis of clast size after Fisher (1966).

Within the map area the tufts are dark, fine-grained rocks which show a clastic texture on the weathered surface where mafic grains are visible. These rocks are uncommon and form narrow units not greater than 60 m wide occurring in the southwestern and central parts of Natal Township.

Lapilli tufts are also uncommon in the map-area, occurring as narrow units not exceeding about 30 m in width in south-central and eastern Natal Township and northeastern Knight Township. The rocks are dark greenish black and consist of angular to subangular fragments of aphanitic basaltic rock averaging 6 by 3 mm set in a very fine-grained dark matrix. The fragments form about 15 percent of the rock.

INTERMEDIATE CALC-ALKALIC METAVOLCANICS.

Lavas. The intermediate lavas are green or grey in colour and are aphanitic, porphyritic, amygdaloidal and pillowed. Some of the aphanitic varieties resemble the greenish-grey mafic and ultramafic rocks but the intermediate rocks lack the quench textures observed on the weathered surfaces of the mafic and ultramafic rocks.

The microtexture of a green, megascopically aphanitic example is shown in Photo 7. This rock can just barely be scratched by a knife. In thin section the rock shows tabular and lath-shaped euhedral and subhedral phenocrysts of saussuritized feldspar in a microcrystalline quartzofeldspathic matrix. Pale green chlorite filling irregular vesicles is scattered through the matrix which also contains scattered irregular grains of leucoxene. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample R9-14) are given in Tables 10, 11, and 12 respectively. The equivalent norm is given in Table 13. The rock is classed as a calc-alkalic high-alumina andesite in the chemical classification of Irvine and Baragar (1971), as shown by Figures 5 and 7.

Another megascopically aphanitic rock, here classed with the lavas, is greenish-grey in colour, and in thin section shows subhedral and anhedral grains of brownish sericitized and carbonatized plagioclase, too altered for optical determination, set in a microcrystalline matrix of quartz and dusky sericitized and carbonatized feldspar. Some clear parts of the matrix contain orthoclase. Accessory minerals are apatite and leucoxene after ilmenite. The unadjusted and adjusted chemical analyses and cation percentages of this rock (S5-3) are given in Tables 10, 11, and 12, and the equivalent norm in Table 13. The rock is classed as a calc-alkalic high-alumina dacite in the chemical classification of Irvine and Baragar (1971), as shown by Figures 5 and 7.

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An example of a green megascopically porphyritic type which forms the matrix of a tuff-breccia, shows phenocrysts of euhedral and subhedral pale green to light grey feldspars, averaging 2 mm wide by 3 mm long, set in an aphanitic green matrix. In thin section the rock is seen to consist of euhedral and subhedral sericitized and saussuritized plagioclase (albite) and less common euhedral and subhedral phenocrysts of carbonatized, epidotized, and chloritized hornblende, in a cryptocrystalline quartzofeldspathic matrix. Irregularly shaped cusped, chlorite-filled vesicles are scattered through the matrix. Accessory opaque leucoxene after ilmenite is present. The unadjusted and adjusted chemical analyses and cation percentages of the rock (sample R9-15) are given in Tables 10, 11, and 12 respectively, and the equivalent norm in Table 13. The rock is classed as a calc-alkalic, high-alumina dacite in the chemical classification of Irvine and Baragar (1971), as shown by Figures 5 and 7.

Pillowed andesites are not very well developed in the area. They are light green in colour. One pillowed flow was located in northeastern Knight Township, and this showed pillows about 45 cm long by 15-25 cm wide, and well developed chilled margins.

A pale greenish grey breccia consists of angular fragments of aphanitic volcanic rock; the fragments range from 8 to 12 cm in width, and are set in a matrix of similar type. The rock is regarded as a flow-top breccia by the author.

Pyroclastic Rocks. Intermediate pyroclastic rocks are subdivided on the basis of predominant clast size (after Fisher 1966) into tuff, lapilli tuff and tuff-breccia. The clasts in the lapilli tuff and tuff-breccia may be angular, subrounded or rounded. The commonest type is fine- to medium-grained tuff; lapilli tuff is less common and tuff-breccia is rare. The pyroclastic rocks are best exposed in Natal Township.

The tuffs are green, grey, or dark grey, aphanitic or fine- to medium-grained rocks,



OGS 10502

Photo 7. Photomicrograph of micro-porphyritic calc-alkalic, high-alumina basalt. Crossed nicols. Specimen R9-14.

TABLE 10. CHEMICAL ANALYSES* (WEIGHT PERCENT) AND SPECIFIC GRAVITY OF SELECTED SUBALKALIC INTERMEDIATE METAVOLCANICS.

Specimen	1 R9-14	2 R9-15	3 P2-2	4 85-3
SiO ₂	60.80	61.7	57.6	60.6
Al ₂ O ₃	16.60	16.40	16.0	15.1
Fe ₂ O ₃	0.88	1.36	2.04	1.29
FeO	3.41	3.73	3.03	2.82
MgO	3.06	2.98	4.22	2.61
CaO	3.65	3.32	6.39	3.25
Na ₂ O	3.32	5.11	4.80	5.19
K ₂ O	2.12	1.74	1.86	2.06
TiO ₂	0.58	0.81	0.56	0.48
P ₂ O ₅	0.13	0.18	0.11	0.14
S	0.02	0.00	0.02	0.04
MnO	0.07	0.09	0.10	0.07
CO ₂	2.34	1.30	0.41	4.32
H ₂ O ⁺	2.39	1.99	0.97	1.42
H ₂ O ⁻	0.53	0.29	0.43	0.32
TOTAL	99.90	101.0	98.5	99.7
SPEC. GR.	2.70	2.74	2.80	2.67

SPECIMENS:

- 1) Andesite (calc-alkalic, high alumina), from outcrop on power transmission line, 400 m NNW of Arthur Lake, south-eastern Natal Township.
- 2) Dacite (calc-alkalic, high alumina), from outcrop 200 m N of specimen R9-14.
- 3) Andesite (calc-alkalic, high alumina), from outcrop 2.4 km NNW of the western end of Little Pigeon Lake, north-western Natal Township.
- 4) Dacite (calc-alkalic, high alumina), from outcrop about 1200 m S of midwestern end of Natal Lake, Natal Township.

*Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

TABLE 11. CHEMICAL ANALYSES (WEIGHT PERCENT) OF SELECTED SUBALKALIC INTERMEDIATE METAVOLCANICS RECALCULATED TO A WATER- AND CARBON DIOXIDE-FREE BASIS.

Specimen	1 R9-14	2 R9-15	3 P2-2	4 85-3
SiO ₂	64.20	63.30	59.60	64.70
Al ₂ O ₃	17.50	16.80	16.50	16.10
Fe ₂ O ₃	0.93	1.40	2.11	1.38
FeO	3.60	3.83	3.13	3.01
MgO	3.23	3.06	4.36	2.79
CaO	3.86	3.41	6.61	3.47
Na ₂ O	3.51	5.25	4.96	5.54
K ₂ O	2.24	1.79	1.92	2.20
TiO ₂	0.61	0.83	0.58	0.51
P ₂ O ₅	0.14	0.18	0.11	0.15
S	0.02	0.00	0.02	0.04
MnO	0.07	0.09	0.10	0.07
TOTAL	99.67	99.94	100.00	99.73

SPECIMENS: See Table 10.

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TABLE 12. CATION PERCENTAGES OF SELECTED INTERMEDIATE METAVOLCANICS.

Specimen	1 R9-14	2 R9-15	3 P2-2	4 S5-3
Si ⁴⁺	59.50	58.10	54.30	59.20
Al ³⁺	19.20	18.20	17.80	17.40
Fe ³⁺	0.65	0.96	1.45	0.95
Fe ²⁺	2.85	3.01	2.47	2.36
Mg ²⁺	4.46	4.18	5.93	3.80
Ca ²⁺	3.83	3.35	6.46	3.40
Na ⁺	6.30	9.33	8.78	9.83
K ⁺	2.65	2.09	2.24	2.57
Th ⁴⁺	0.43	0.57	0.40	0.35
P ⁵⁺	0.11	0.14	0.09	0.12
S	0.04	0.00	0.04	0.07
TOTAL	99.92	99.93	99.96	100.05

SPECIMENS: See Table 10.

*Fe²⁺ includes Mn²⁺

TABLE 13. EQUIVALENT NORM OF SELECTED INTERMEDIATE SUBALKALIC METAVOLCANICS.

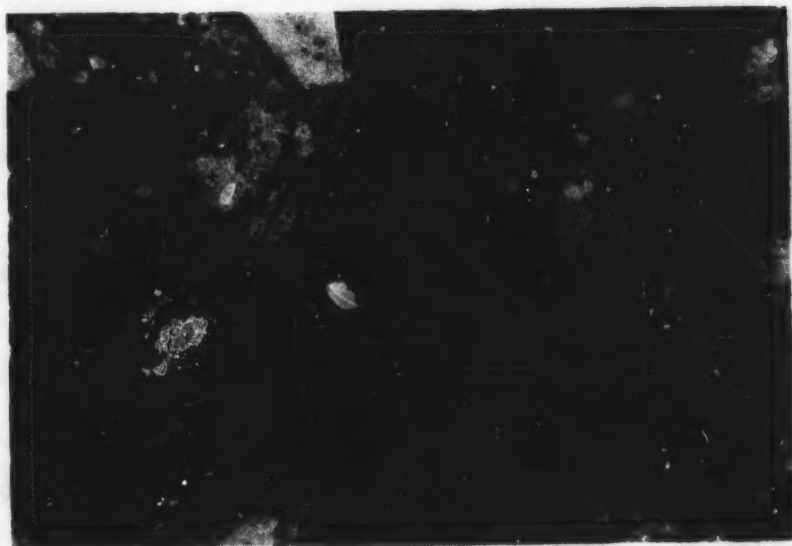
Specimen	1 R9-14	2 R9-15	3 P2-2	4 S5-3
Quartz	18.84	11.49	4.34	11.03
Corundum	2.91	0.56	0.00	0.00
Acmite	0.00	0.00	0.00	0.00
Orthoclase	13.25	10.47	11.21	12.85
Albite	31.51	46.67	43.90	49.13
Anorthite	18.25	15.56	16.93	12.46
Leucite	0.00	0.00	0.00	0.00
Nepheline	0.00	0.00	0.00	0.00
Kaliophilite	0.00	0.00	0.00	0.00
Diopside	0.00	0.00	9.59	2.06
Hedenbergite	0.00	0.00	2.13	0.79
Enstatite	8.93	8.37	7.06	6.57
Ferrosilite	4.13	3.91	1.57	2.53
Forsterite	0.00	0.00	0.00	0.00
Fayalite	0.00	0.00	0.00	0.00
Magnetite	0.97	1.45	2.17	1.42
Ilmenite	0.85	1.15	0.80	0.71
Apatite	0.29	0.38	0.24	0.31
Pyrrhotite	0.07	0.00	0.07	0.15
TOTAL	100.00	100.01	100.03	100.01

SPECIMENS: See Table 10.

and show crystals of feldspar, and minor quartz and hornblende on the weathered surface. The microtexture of the coarser tuff is shown in Photo 8. The rock consists of broken subhedral and anhedral crystals of altered and unaltered plagioclase (An_{17}), euhedral, subhedral and anhedral hornblende, and pale greenish diopside augite in a matrix of altered feldspar containing epidote, calcite, chlorite, apatite, square, rectangular and irregular pyrite, and leucoxene after ilmenite. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample P2-2) are given in Tables 10, 11, and 12 respectively, and the equivalent norm in Table 13. This rock is not highly altered chemically, and in the chemical classification of Irvine and Baragar (1971) it is a calc-alkalic high-alumina andesite, as shown in Figures 5 and 7. This rock type is very common in Natal Township and comprises about two-thirds of the subalkalic volcanic rocks exposed there. It forms either massive, non-bedded units or graded units varying from 1 cm to about 45 cm in thickness. The units grade from coarse tuff to an aphanitic hard, cherty, greenish rock, or to black chert. The microtexture of a hard greenish cherty facies is shown in Photo 9. This rock cannot be scratched by a knife. Its fragmental nature is apparent. In the chemical classification of Irvine and Baragar (1971) the rock is calc-alkalic rhyolite, and is thus described under the subalkalic felsic metavolcanics (below). Load casting, and flame and ball lithostructures are present in these rocks and are perfectly preserved. In some cases banding in the cherty upper part is well shown on the weathered surface.

Lapilli tuff is grey or green in colour and shows fragments mainly of aphanitic intermediate volcanic rocks in a tuffaceous matrix. The fragments are from 5 mm to 20 mm across and are both rounded and angular. In these rocks stratification is not present. They are commoner in the southeastern and eastern parts of Natal Township.

Tuff-breccia is the rarest of the pyroclastics and was encountered only in eastern Natal Township. These rocks are light grey and greenish grey and show mixtures of both angular



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Photo 8. Photomicrograph of calc-alkalic high-alumina andesite tuff. Crossed nicols. Specimen P2-2.

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and rounded blocks varying from about 9 to 45 cm across. They consist of aphanitic and porphyritic intermediate volcanic rocks in a crystal-tuff matrix of intermediate composition. The best exposures are seen about half way along the Ontario Hydro transmission line in eastern Natal Township.

FELSIC CALC-ALKALIC METAVOLCANICS. The felsic metavolcanics are light grey, dark grey, or pink, megascopically aphanitic or porphyritic rocks. These rocks are not abundant in the map-area, and were encountered only in southeastern Natal Township, at the central part of the western boundary of Knight Township, and in northeastern Knight Township. Felsic metavolcanics are also interpreted to underlie areas near Moon Lake in southwestern Knight Township. Pyroclastics have been mapped as such only where clastic texture has been observed at outcrop. Thus, aphanitic rocks may be lavas or pyroclastics. A green megascopical aphanitic rock forming the upper part of the intermediate tuffs is described here as it is classed as a rhyolite in the chemical classification of Irvine and Baragar (1971).

Lavas. An example of a porphyritic felsic flow (map-unit 4b) is buff coloured and consists of subhedral phenocrysts of quartz and feldspar 2-3 mm in diameter, and greenish-black and black lath-shaped ferromagnesian minerals measuring 1 by 2 mm, set in an aphanitic buff coloured matrix. Thin section shows the rock to be composed dominantly of dusky sericitized albite (An_{40}) phenocrysts; euhedral, subhedral and rounded quartz grains; subhedral, bleached and chloritized biotite; and carbonatized and chloritized hornblende in an altered microcrystalline quartzofeldspathic matrix. Some of the altered hornblende is euhedral. The opaque mineral is leucoxene. The quartz phenocrysts show wavy extinction due to strain. The unadjusted and adjusted chemical analyses and cation percentages of this



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Photo 9. Photomicrograph of cherty, calc-alkalic, upper part of tuff unit shown in Photo 8. Crossed nicols. Specimen Q3-8a.

TABLE 14. CHEMICAL ANALYSES* (WEIGHT PERCENT) AND SPECIFIC GRAVITY OF SELECTED SUBALKALIC FELSIC METAVOLCANICS.

Specimen	1 Q8-18	2 Q8-19	3 Q14-14a	4 Q3-8a
SiO ₂	70.3	69.9	69.4	69.2
Al ₂ O ₃	15.8	17.0	16.6	14.9
Fe ₂ O ₃	0.52	1.25	0.94	1.29
FeO	1.06	0.66	0.85	2.04
MgO	0.74	0.54	0.77	2.62
CaO	1.95	0.73	1.31	0.62
Na ₂ O	5.80	7.25	6.87	5.80
K ₂ O	1.81	1.52	1.88	1.12
TiO ₂	0.30	0.34	0.20	0.48
P ₂ O ₅	0.10	0.08	0.05	0.14
S	0.01	0.00	0.22	0.05
MnO	0.03	0.02	0.03	0.03
CO ₂	1.30	0.28	0.65	0.11
H ₂ O ⁺	0.70	1.00	0.53	1.80
H ₂ O ⁻	0.39	0.13	0.20	0.14
TOTAL	100.8	100.7	100.5	100.5
SPEC. GR.	2.66	2.62	2.65	2.70

SPECIMENS:

- 1) Rhyolite (calc-alkalic, high alumina), from outcrop about 800 m NNE of Arthur Lake, near central part of western boundary of Knight Township.
- 2) Rhyolite (calc-alkalic, high alumina), from outcrop 800 m NE of Arthur Lake, near central part of western boundary of Knight Township.
- 3) Rhyolite (calc-alkalic, high alumina), about 800 m W of middle part of the western shore of Latricain Lake, north-eastern Knight Township.
- 4) Rhyolite (calc-alkalic), from outcrop about 400 m WNW of western end of Little Pigeon Lake, northwestern Natal Township.

*Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

TABLE 15. CHEMICAL ANALYSES (WEIGHT PERCENT) OF SELECTED SUBALKALIC FELSIC METAVOLCANICS RECALCULATED TO A WATER- AND CARBON DIOXIDE-FREE BASIS.

Specimen	1 Q8-18	2 Q8-19	3 Q14-14a	4 Q3-8a
SiO ₂	71.40	70.40	70.00	70.30
Al ₂ O ₃	16.10	17.10	16.70	15.10
Fe ₂ O ₃	0.53	1.26	0.95	1.31
FeO	1.08	0.66	0.86	2.07
MgO	0.75	0.54	0.78	2.66
CaO	1.98	0.74	1.32	0.83
Na ₂ O	5.89	7.30	6.93	5.89
K ₂ O	1.84	1.53	1.90	1.14
TiO ₂	0.30	0.34	0.20	0.49
P ₂ O ₅	0.10	0.08	0.05	0.14
S	0.01	0.00	0.22	0.05
MnO	0.03	0.02	0.03	0.03
TOTAL	100.01	99.97	99.94	100.01

SPECIMENS: See Table 14.

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TABLE 16. CATION PERCENTAGES OF SELECTED SUBALKALIC FELSIC METAVOLCANICS.

Specimen	1 Q8-18	2 Q8-19	3 Q14-14a	4 Q8-9a
Si ⁴⁺	65.50	63.90	63.50	64.40
Al ³⁺	17.40	18.30	17.90	16.30
Fe ³⁺	0.36	0.86	0.65	0.90
Fe ²⁺	0.85	0.52	0.67	1.61
Mg ²⁺	1.03	0.74	1.05	3.63
Ca ²⁺	1.95	0.72	1.28	0.82
Na ⁺	10.48	12.85	12.19	10.46
K ⁺	2.15	1.78	2.20	1.33
Ti ⁴⁺	0.21	0.23	0.14	0.34
P ⁵⁺	0.08	0.06	0.04	0.11
S	0.02	0.00	0.38	0.08
TOTAL	100.03	99.96	100.00	99.99

SPECIMENS: See Table 14.

*Fe²⁺ includes Mn²⁺

TABLE 17. EQUIVALENT NORM, COLOUR INDEX, AND NORMATIVE PLAGIOCLASE COMPOSITION OF SELECTED SUBALKALIC FELSIC METAVOLCANICS.

Specimen	1 Q8-18	2 Q8-19	3 Q14-14a	4 Q8-9a
Quartz	22.52	18.08	16.86	23.37
Corundum	1.09	2.47	1.08	3.28
Acmite	0.00	0.00	0.00	0.00
Orthoclase	10.77	8.88	10.99	6.65
Albite	52.40	64.27	60.94	52.30
Anorthite	9.08	3.06	6.10	3.17
Leucite	0.00	0.00	0.00	0.00
Nepheline	0.00	0.00	0.00	0.00
Kaliophyllite	0.00	0.00	0.00	0.00
Diopside	0.00	0.00	0.00	0.00
Hedenbergite	0.00	0.00	0.00	0.00
Enstatite	2.06	1.47	2.10	7.27
Ferrocalcite	0.88	0.00	0.00	1.47
Forsterite	0.00	0.00	0.00	0.00
Fayalite	0.00	0.00	0.00	0.00
Hemattite	0.00	0.29	0.33	0.00
Magnetite	0.55	0.88	0.48	1.36
Ilmenite	0.42	0.47	0.28	0.67
Apatite	0.21	0.17	0.10	0.29
Pyrrhotite	0.04	0.00	0.76	0.17
TOTAL	100.02	100.02	100.02	100.00
Equivalent colour index	3.90	3.09	3.18	10.76
Plagioclase	Oligoclase	Albite	Albite	Albite
% An	14.77	4.54	9.10	5.71

SPECIMENS: See Table 14.

rock (sample Q8-16) are given in Tables 14, 15, and 16 respectively, and the equivalent norm in Table 17. In the chemical classification of Irvine and Barager (1971) the rock is calc-alkalic, high-alumina rhyolite as shown by Figures 5 and 7. Another similar but pink porphyritic felsic volcanic rock (sample Q8-19) was chemically analysed. The unadjusted and adjusted chemical analyses of this rock and the cation percentages are given in Tables 14, 15, and 16 respectively. The equivalent norm is given in Table 17. The rock is classed as a calc-alkalic, high-alumina rhyolite in the chemical classification of Irvine and Barager (1971) as shown by Figures 5 and 7.

Pyroclastic Rocks. Felsic pyroclastic rocks are subdivided on the basis of the predominant clast size into tuff and lapilli tuff after Fisher (1966). These rocks are very rare in the area.

The microtexture of a megascopically aphanitic tuff is shown in Photo 10. The rock is light grey in colour and cannot be scratched with a knife. In thin section it shows an unsorted mixture of euhedral, subhedral and anhedral grains of albite (An_2) and less numerous irregular grains of quartz in a matrix of potassium feldspar and quartz. Opaque euhedral and irregular grains of pyrite and leucosane are scattered through the rock. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample Q14-14a) are given in Tables 14, 15, and 16 respectively. The equivalent norm is given in Table 17. In the chemical classification of Irvine and Barager (1971) the rock is calc-alkalic, high-alumina rhyolite, as shown by Figures 5 and 7. The equivalent colour index of the rock is 3.

An example of another megascopically aphanitic felsic tuff occurs as a dark grey-green cherty rock forming the upper fine-grained part of a graded bedded unit of the calc-alkalic intermediate rocks located in northwestern Natal Township. It consists of subhedral and anhedral crystals of altered feldspar with minor quartz grains in a cloudy dusky matrix



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Photo 10. Photomicrograph of calc-alkalic, high-alumina rhyolite tuff. Crossed nicols. Specimen Q14-14a.

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of altered feldspar, which contains irregular grains of pale green chlorite, epidote and opaque to translucent sphene. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample Q3-8a) are given in Tables 14, 15, and 16 respectively. The equivalent norm is given in Table 17. In the classification of Irvine and Baragar (1971) this rock is calc-alkalic rhyolite, as shown by Figures 5 and 7.

Only one exposure of lapilli tuff was observed. This rock was pale yellow-green and consisted of angular fragments, 20 mm in diameter, of felsic aphanitic volcanic rock in an aphanitic matrix. Bedding is entirely absent at the outcrop. Irregular grains of feldspar up to 3 mm long occur sporadically in the matrix material.

ALKALIC METAVOLCANICS

The alkalic metavolcanics are dark purplish-green, dark purple, reddish brown or red, aphanitic, and porphyritic rocks. Both lavas and pyroclastics have been observed. Pillowed lithostructures are absent. Where the rocks are porphyritic they commonly contain dark green hornblende phenocrysts; feldspar phenocrysts are less common. The alkalic rocks are best developed in southeastern Natal Township. The rocks were chemically classified using the method of Irvine and Baragar (1971), but the MacDonald (1968) dividing line on the silica-alkalies weight percent plot (see Figure 2) was used in categorizing the rocks as alkalic or subalkalic, because it gives a more consistent classification of rocks of similar field characteristics. No attempt was made to divide the rocks into sodic or potassic series in the field.

MAFIC ALKALIC METAVOLCANICS.

Lavas. An example of a porphyritic flow classed as hawailite (Figure 9) is dark green and



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Photo 11. Photomicrograph of porphyritic hawailite. Crossed nicols. Specimen R11-9.

contains crystals of amphibole 3 mm long by 1 mm across. The microtexture of the rock is shown in Photo 11. In thin section the rock is seen to consist of phenocrysts of euhedral and subhedral hornblende, some of which are altered to chlorite and epidote, and ovoid to irregularly shaped grains of granular epidote (probably after diopsidic augite by comparison with similar-looking fresher rocks), set in a pilotaxitic matrix of strained albitic plagioclase. Granular, irregularly shaped grains of dusky-brown epidote, opaque grains of pyrite, leucoxene, and sphene after leucoxene are scattered through the matrix. The unadjusted and adjusted chemical analyses and cation percentages of the rock (sample R11-9) are given in Tables 18, 19, and 20. The equivalent norm is given in Table 21. Using the silica-alkalies weight percent diagram (Figure 2) (Figure 3 in Irvine and Baragar 1971), and the dividing line of MacDonald (1968) the rock plots in the alkalic field. Then, using Figures 8 and 9 (Figures 9 and 11 in Irvine and Baragar 1971), the rock is finally classed as a hawaiite. If the alkalic-subalkalic divider of Irvine and Baragar were used (Figure 2) the rock would be classified as a calc-alkalic andesite. The specific gravity of the rock is 2.87.

Another rock regarded as a hawaiite by the author but classed as a calc-alkalic andesite in the chemical classification of Irvine and Baragar (1971) using the same procedures as above, is dark, fine grained, aphanitic and purplish black in colour. The microtexture of the rock is shown in Photo 12. In thin section the rock is seen to contain phenocrysts of hornblende and less common, partially altered, phenocrysts of pale greenish diopsidic augite in a pilotaxitic matrix of altered and strained plagioclase, and interstitial patches of potassic feldspar, calcite and chlorite. Opaque minerals consist of ilmenite, magnetite and pyrite. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample R10-27) are given in Tables 18, 19, and 20 respectively. The equivalent norm is given in Table 21. Using the Irvine-Baragar divider, the rock is subalkalic and classed as a calc-alkalic andesite. Using MacDonald's divider (Figure 2), the rock plots just below the line and in the subalkalic field. However, because of the lithological characteristics, the mi-



Photo 12. Photomicrograph of hawaiite. Crossed nicols. Specimen R10-27.

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TABLE 18. CHEMICAL ANALYSES* (WEIGHT PERCENT) AND SPECIFIC GRAVITY OF SELECTED ALKALIC METAVOLCANICS.

Specimen	1 R11-9	2 R10-27	3 G8-32a	4 R10-2	5 S7-13
SiO ₂	52.9	56.3	49.3	61.1	63.4
Al ₂ O ₃	15.5	14.5	14.2	14.7	16.1
Fe ₂ O ₃	2.86	2.86	5.42	1.29	1.64
FeO	4.78	4.70	6.83	1.62	2.04
MgO	7.39	6.24	6.66	1.70	1.53
CaO	7.33	4.36	6.95	3.15	2.82
Na ₂ O	4.42	4.72	3.37	2.75	8.54
K ₂ O	1.37	1.95	3.12	7.22	0.48
TiO ₂	1.05	0.76	1.10	0.68	0.46
P ₂ O ₅	0.20	0.20	0.42	0.47	0.11
S	0.72	0.01	0.01	0.24	0.01
MnO	0.15	0.02	0.21	0.04	0.05
CO ₂	0.21	0.44	0.20	1.70	1.73
H ₂ O ⁺	0.72	1.37	2.13	0.95	1.12
H ₂ O ⁻	0.60	0.86	0.25	0.78	0.21
TOTAL	100.2	99.3	100.3	98.4	100.2
SPEC. GR.	2.87	2.80	2.92	2.62	2.65

SPECIMENS:

- 1) Hawailla (sodic alkali-basalt series), from outcrop at southwestern shore of southwestern fork of southern end of Pigeon Lake, south-central Knight Township.
- 2) Hawailla (sodic alkali-basalt series), from outcrop 800 m east of the northern end of Arthur Lake, west-central Knight Township.
- 3) Trachybasalt (potassic alkali-basalt series), from outcrop 1.6 km NNW of the north end of Arthur Lake, southeast Natal Township.
- 4) Tristramite (potassic alkali-basalt series), from outcrop 400 m SE of middle part of east shore of Arthur Lake, west-central boundary of Knight Township.
- 5) Trachyte, sodic (sodic alkali-basalt series), from outcrop on south shore of West Montreal River, 400 m NW of Berle Lake, southeast Natal Township.

*Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

TABLE 19. CHEMICAL ANALYSES (WEIGHT PERCENT) OF SELECTED ALKALIC METAVOLCANICS RECALCULATED TO A WATER- AND CARBON DIOXIDE-FREE BASIS.

Specimen	1 R11-9	2 R10-27	3 G8-32a	4 R10-2	5 S7-13
SiO ₂	53.60	58.30	50.80	64.30	65.30
Al ₂ O ₃	15.70	15.00	14.60	15.50	16.60
Fe ₂ O ₃	2.59	2.34	2.67	1.36	1.69
FeO	5.13	5.43	9.61	1.71	2.10
MgO	7.49	6.46	6.84	1.79	1.58
CaO	7.43	4.51	7.13	3.32	2.90
Na ₂ O	4.48	4.89	3.46	2.90	8.79
K ₂ O	1.39	2.02	3.20	7.80	0.49
TiO ₂	1.06	0.79	1.13	0.72	0.47
P ₂ O ₅	0.20	0.21	0.43	0.49	0.11
S	0.73	0.01	0.01	0.25	0.01
MnO	0.15	0.02	0.22	0.04	0.05
TOTAL	99.95	99.98	99.90	99.96	100.09

SPECIMENS: See Table 18.

TABLE 20. CATION PERCENTAGES OF SELECTED ALKALIC METAVOLCANICS.

Specimen	1 R11-8	2 R10-27	3 Q8-32a	4 R10-2	5 S7-13
Si ⁴⁺	48.60	53.20	46.90	59.50	58.50
Al ³⁺	16.80	16.10	15.90	16.90	17.50
Fe ³⁺	1.76	1.61	1.86	0.95	1.14
Fe ²⁺	4.00	4.16	7.62	1.35	1.61
Mg ²⁺	10.11	8.78	9.44	2.47	2.11
Ca ²⁺	7.21	4.41	7.09	3.29	2.79
Na ⁺	7.87	8.64	6.22	5.20	15.29
K ⁺	1.61	2.35	3.79	8.99	0.57
Ti ⁴⁺	0.72	0.54	0.79	0.50	0.32
P ⁵⁺	0.16	0.16	0.34	0.39	0.09
S	1.24	0.02	0.02	0.44	0.02
TOTAL	100.08	99.97	99.97	99.98	99.94

SPECIMENS: See Table 18.

*Fe²⁺ includes Mn²⁺

TABLE 21. EQUIVALENT NORM, COLOUR INDEX, AND NORMATIVE PLAGIOCLASE COMPOSITION OF SELECTED ALKALIC METAVOLCANICS.

Specimen	1 R11-8	2 R10-27	3 Q8-32a	4 R10-2	5 S7-13
Quartz	0.00	1.89	0.00	10.54	4.69
Corundum	0.00	0.00	0.00	0.00	0.00
Acmite	0.00	0.00	0.00	0.00	0.00
Orthoclase	8.03	11.76	18.96	44.93	2.83
Albite	39.33	43.22	25.98	25.98	76.45
Anorthite	18.25	12.87	14.79	6.76	4.17
Leucite	0.00	0.00	0.00	0.00	0.00
Nepheline	0.00	0.00	3.06	0.00	0.00
Kaliophilite	0.00	0.00	0.00	0.00	0.00
Diopside	11.85	4.77	8.78	5.16	5.43
Hedenbergite	1.36	1.52	5.47	0.00	1.82
Enstatite	8.11	15.18	0.00	2.36	1.50
Ferrosillite	0.93	4.83	0.00	0.00	0.50
Forsterite	4.64	0.00	10.88	0.00	0.00
Fayalite	0.53	0.00	6.78	0.00	0.00
Hematite	0.00	0.00	0.00	0.11	0.00
Magnetite	2.84	2.41	2.79	1.25	1.71
Ilmenite	1.45	1.08	1.57	1.00	0.64
Apatite	0.42	0.43	0.90	1.04	0.23
Pyrrhotite	2.48	0.04	0.04	0.86	0.04
TOTAL	100.02	100.00	100.00	100.01	100.01
Equivalent colour index	31.50	29.79	36.27	9.88	11.60
Plagioclase	Oligoclase	Andesine	Andesine	Oligoclase	Albite
% An	31.89	22.95	32.25	20.65	5.18

SPECIMENS: See Table 18.

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crotexture and the slightly altered nature of the rock, the rock is considered alkalic by the author. The rock clearly resembles the hawaiite previously described. Using Figures 8 and 9, the rock is subsequently classed as a hawaiite. The specific gravity of the rock is 2.80.

Pyroclastic Rocks. The pyroclastic rocks are subdivided on the basis of predominant clast size into tuff, lapilli tuff and tuff-breccia after Fisher (1966).

A lapilli tuff classed as a trachybasalt, potassic series, in the chemical classification of Irvine and Baragar (1971) consists of fragments 60 mm across, dark green in colour with a purplish hue on the weathered surface, and shows subhedral crystals of dark green amphibole 2 mm long by 1 mm wide. The microtexture of the rock is shown in Photo 13, in which euhedral and subhedral phenocrysts of fresh, and chloritized, colourless to slightly pale green, diopside augite, are set in a matrix of only slightly altered, randomly oriented, lath-shaped grains of plagioclase (albite, An_0). The plagioclase laths are surrounded by pale green and brownish green chloritic and epidotic materials. Subhedral and anhedral opaque grains of pyrite are scattered through the rock. The unadjusted and adjusted chemical analyses and cation percentages of this rock (sample Q8-32a) are given in Tables 18, 19, and 20 respectively. The equivalent norm is given in Table 21. The barium content of this rock is 1080 ppm, and the strontium content 700 ppm. These high values are noteworthy as barium would be expected to substitute for potassium in these potassic rocks. This rock plots as alkalic on the silica-alkalies diagram (Figure 2), using either the MacDonald divider or the Irvine and Baragar divider, and also on the $Ol'Ne'-Q'$ diagram (Figure 3). Using Figures 8 and 10 the rock is classed as a trachybasalt. The specific gravity of the rock is 2.92.

Most of the fragments in the tuff-breccia are between 10 and 15 cm across and are both angular and rounded. Predominantly, they are porphyritic, consisting of acicular and



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Photo 13. Photomicrograph of porphyritic trachybasalt clast in alkalic lapilli tuff. Crossed nicols. Specimen Q8-32a.

lath-shaped crystals of hornblende up to 5 mm long by 2 mm wide in a dark mauve matrix. These are well developed along the eastern shore of West Montreal River below Elbow Rapids, in southeastern Natal Township. One example occurring on the Ontario Hydro transmission line at a point 1.2 km northwest of the northern end of Arthur Lake, eastern Natal Township, contains rounded blocks of pyroxene alkali-basalt, similar to that described above, 15 cm across on the average, set in a dark green fine-grained matrix. Some of the blocks are as large as 0.6 m.

INTERMEDIATE ALKALIC METAVOLCANICS. Rocks grouped here are represented by potassic and sodic trachytes. They are purple or brick-red in colour, and are aphyric or porphyritic.

Lavas. A porphyritic, intermediate alkalic flow is brick red in colour and shows green, chloritized, lath-shaped amphibole grains 3 mm long by 1 mm wide and phenocrysts of equant, grey, and pale pink feldspar 1 mm across, in a fine-grained, brick-red matrix. Its microtexture is shown in Photo 14. In thin section the rock is seen to be altered and contains euhedral and subhedral altered brown plagioclase (where unaltered it is albite, An_0) and chloritized actinolite, in an altered, microgranular matrix of quartz and potassic feldspar. Accessory minerals are calcite, chlorite, apatite, and pyrite. The unadjusted and adjusted chemical analyses and cation percentages of the rock (sample R10-2) are given in Tables 18, 19 and 20 respectively. The equivalent norm is given in Table 21. In the classification of Irvine and Baragar (1971), using initially the $Ol'-Ne'-Q'$ plot (Figure 3), the rock is subalkalic and would subsequently be classed as a calc-alkalic dacite. However, using initially



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Photo 14. Photomicrograph of porphyritic tristanite, potassic series. Crossed nicols. Specimen R10-2.

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the silica-alkalies diagram (Figure 2) and either the MacDonald (1968) or the Irvine and Baragar (1971) divider, along with Figures 8 and 10, the rock is classed as a tristanite, potassic series. The high content of total alkalies of 10.50 percent at a silica content at 64.3 percent and the barium and strontium contents of 1100 ppm and 400 ppm respectively, indicate the alkalic nature of this rock. This rock is only moderately altered as shown by thin section examination and total $H_2O + CO_2$ of 2.85 percent. The summation of 98.4 percent for the analysis is, however, low. Its specific gravity is 2.62.

Pyroclastic Rocks. The tuffs are fine-grained purplish rocks which show small crystals of feldspar 0.5-1 mm across on the weathered surface. They are best developed in the southeastern corner of Natal Township. The microtexture of a tuff belonging to the sodic alkali-basalt series is shown in Photo 15. This rock is purple and porphyritic, with crystals of grey and pale pink feldspar 1 mm across in an aphanitic purplish matrix. In thin section euhedral and subhedral fresh albite (An_4) crystals are set in a slightly altered, microgranular matrix of quartz and alkali feldspar, containing irregular patchy areas of calcite, chlorite, apatite and irregular grains of leucoxene. The unadjusted and adjusted chemical analyses and the cation percentages of this rock (sample S7-13) are given in Tables 18, 19, and 20 respectively. The equivalent norm is given in Table 21. The rock is classed as a trachyte, sodic series, in the classification of Irvine and Baragar (1971). The barium content of the rock is 100 ppm, the strontium content 300 ppm. The low barium content of this rock is consistent with its being sodic rather than potassic. The rock plots as subalkalic on Figure 2 using either divider, but as alkalic on Figure 3. In both cases the rock composition plots close to the dividing line.

Lapilli tuffs are similar in colour to the tuffs and have fragments, ranging from 6 mm to 3 cm in size, of porphyritic and aphanitic alkalic rocks in a massive matrix. The fragments consist of the same rock types described above under "Flows". Where the clasts are porphyritic, the phenocrysts are of feldspar or hornblende.



OGS 10510

Photo 15. Photomicrograph of trachyte tuff, sodic series. Crossed nicols. Specimen S7-13.

Metasediments

Metasediments are interlayered with the volcanic rocks, but are not common in the map-area. They comprise chert and wacke forming thin units about 50 m wide. They were found in areas (1) about 1.2 km northwest of the western end of Natal Lake, (2) about 0.8 km northwest of the western end of Little Pigeon Lake in northwestern Natal Township, and (3) on the western shore of Bigfour Lake in southern Natal Township.

The chert consists of grey thin-bedded units 8 cm thick associated with dark grey wacke. The rocks dip sub-vertically, and this served to separate the Early Precambrian sedimentary rocks from Middle Precambrian units unconformably overlying them.

The wacke units are dark-grey to black fine-grained rocks.

Felsic to Intermediate Intrusive Rocks

Felsic to intermediate intrusive rocks occur in two areas: in northeastern Knight Township, and at the west-central part of the southern boundary of Knight Township. The pluton in the former area is referred to as the Lafricain Pluton, and the one in the latter area as the Milly Creek Pluton. Small bodies occurring around these plutons are regarded as satellites: thus the granitic rocks at House Lake in northeastern Knight Township are regarded as part of the Lafricain pluton, and the exposures at the southern end of Pigeon Lake are considered to be parts of the Milly Creek Pluton. The commonest rock types observed in both plutons are grey, or pink to brown, medium-grained massive hornblende granitoid rocks. The pink granitoid rock is porphyritic locally, where feldspar or feldspar and hornblende occur as phenocrysts.

LAFRICAINE PLUTON

The Lafricain Pluton is elongated in a north-northwesterly direction, and is 1.2 km wide on average. The long axis of the pluton is parallel to the regional trend of the metavolcanics.

The commonest rock type of this pluton is a pink to brown, medium-grained, massive granitoid rock. In these rocks, quartz is not commonly visible on the weathered surface. The feldspar is either pink or brownish and the ferromagnesian mineral is greenish black, usually well-crystallized hornblende. Biotite is rarely observed. One example of these rocks shows dark green hornblende as well-crystallized laths measuring 3 mm by 1 mm in a pinkish-brown, medium-grained feldspathic matrix. Quartz is not visible on the weathered surface, and biotite was not observed. In thin section the rock shows hypidiomorphic-granular texture with anhedral quartz, potassic feldspar (microcline and orthoclase) and interstitial to dominant, altered, subhedral, plagioclase (clear parts of which are albite, An_0). The major mafic mineral is euhedral, subhedral and anhedral pleochroic yellow-green hornblende. Accessory minerals are chloritized biotite, sphene, apatite, and opaque magnetite, ilmenite-leucoxene and pyrite. The mode of this rock is given in column 1 of Table 22, and according to the classification of Ayres (1972) is granodiorite or quartz diorite.

Porphyritic rocks are of similar aspect and they contain phenocrysts of hornblende and feldspar in a brownish, medium-grained matrix. One of these rocks shows pale pinkish phenocrysts of equant feldspar, 2 mm across, and lath-shaped dark-green hornblende, 3 mm by 1 mm in size, set in a fine-grained, pinkish-brown feldspathic matrix. No quartz is visible on the weathered surface. Thin section study shows the rock to consist of euhedral and subhedral phenocrysts of altered plagioclase (too altered for optical determination) with less common epidotized and chloritized hornblende laths, in a microgranular matrix of quartz and altered potassic feldspar. The rock is probably a porphyritic quartz monzonite in the classification of Ayres (1972). The mode is given in column 2 of Table 22.

Another example is pink in hand specimen and shows phenocrysts of quartz measuring 4 mm by 3 mm, dark reddish-brown feldspar phenocrysts measuring 7 mm by 5 mm,

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and green hornblende phenocrysts measuring 4 mm by 2 mm, set in a pale-pink, medium-grained, quartzofeldspathic matrix. In thin section the reddish-brown feldspar phenocrysts are seen to consist of altered plagioclase and perthitic feldspar (some grains of which are poikilitic to plagioclase, hornblende and quartz) in a matrix of composite, sutured, interstitial quartz grains, and euhedral and subhedral slightly altered brownish plagioclase (clear parts of which are albite, An_8). The potassic feldspar phenocrysts are particularly highly altered to a dusky brown colour in thin section. The hornblende is pale green pleochroic, and occurs in euhedral and subhedral grains. Accessory minerals consist of sphene, leucocene-sphene, apatite and opaque ilmenite. Most of the ilmenite occurs as subhedral and anhedral grains in the hornblende. The mode of this rock is given in column 3 of Table 22. In the classification of Ayres (1972) the rock is probably a porphyritic quartz monzonite.

An example of grey, massive, hornblende granitoid rock shows in hand specimen about 60 percent grey and pink feldspar and 40 percent hornblende. Quartz was not visible on the weathered or fresh surface. In thin section the rock shows hypidiomorphic-granular texture. Quartz is sparingly present and consists of interstitial, anhedral, simple and composite grains showing wavy extinction due to strain. The feldspar is in subhedral and anhedral grains completely altered to dark brown material and in the cores of some grains to black alteration products. The feldspar is saussuritized plagioclase but less altered parts of grains are albite (An_8). A slight preferred orientation of the feldspar and hornblende is present. The hornblende occurs as subhedral and anhedral grains pleochroic in

TABLE 22. VOLUME PERCENTAGE OF MINERALS IN SELECTED GRANITOID ROCKS.

Specimen	1 P17-100	2 P17-107	3 Q15-21	4 P17-105	5 P17-115	6 S11-2	7 S11-9
Quartz	22	—	30	15	16	0	26
Quartz-orthoclase matrix	—	67	—	—	—	—	—
Potassic feldspar	13	0	34	0	5	0	7
Plagioclase	46	21	25	52	54	52	55
Hornblende	18	0	11	23	24	46	0
Biotite	0	0	0	7	0	0	11
Epidote	0	2	0	1	0	0	0
Chlorite	0	10	0	0	0	0	0
Opaque minerals	—	0	0	2	1	2	1
Sphene	1	0	0	0	0	0	0
Apatite	—	0	0	0	0	0	0
TOTAL	100	100	100	100	100	100	100
Plagioclase composition (% An)	An8	—	An9	An9	An8	An2	An9

SPECIMENS:

Lafrcain Pluton

- 1) Grenodiorite or quartz diorite; from outcrop about 400 m ENE of the middle part of the eastern shore of Lafrcain Lake, northeastern Knight Township.
- 2) Quartz monzonite; from outcrop about 1200 m N of the northern end of Lafrcain Lake, northeastern Knight Township.
- 3) Quartz monzonite; from outcrop about 1200 m ENE of Lafrcain Lake, northeastern Knight Township.
- 4) Trondhjemite or quartz diorite; from outcrop about 1200 m NNE of the northern end of Lafrcain Lake, northeastern Knight Township.
- 5) Trondhjemite or quartz diorite; from outcrop 1200 m E of the northern end of Lafrcain Lake, northeastern Knight Township.

Milly Creek Pluton

- 6) Syendiorite or diorite; from outcrop 400 m SSE of Brush Lake, southwestern Knight Township.
- 7) Trondhjemite or quartz diorite; from outcrop 200 m E of northern end of McIntyre Lake, southwestern Knight Township.

shades of yellow and pale green. Biotite occurs as equant, subhedral, epidotized and chloritized grains some of which are bent. This chlorite is pleochroic in shades of pale yellow and green. Accessory minerals consist of apatite, yellow-green epidote, brownish sphene and opaque magnetite and leucoxene-ilmenite. The mode of this rock is given in column 4 of Table 22. In the classification of Ayres (1972) the rock is trondhjemite or quartz diorite.

Another example of this rock type shows well crystallized laths of hornblende measuring 3 mm by 1 mm on the average, associated with pale brownish feldspar. Quartz is not visible on the weathered surface but can be seen on the fresh surface. In thin section the rock shows hypidiomorphic-granular texture and consists of composite, anhedral grains of interstitial quartz showing wavy extinction, anhedral altered microcline, perthite and orthoclase, dusky subhedral and anhedral sericitized plagioclase (clear portions of which are albite, An_6). Ferromagnesian minerals consist of subhedral hornblende, pleochroic in shades of green and yellow, some of which show simple or multiple twinning, and ragged chloritized biotite. Accessory minerals consist of apatite, epidote, zircon, and opaque minerals are magnetite or ilmenite and leucoxene-ilmenite aggregates. The mode of this rock is given in column 5 of Table 22. In the classification of Ayres (1972) the rock is trondhjemite or quartz diorite.

The granitoid-basalt contact rock consists of angular and rounded fragments of basalt varying from 5 to 10 cm set in the pink hornblende granitoid rock as matrix. The rock occurs at the contact of the granitoid rock and the intruded mafic metavolcanics.

MILLY CREEK PLUTON

Rock types in the Milly Creek Pluton are not as varied as in the Lafricain mass. The most common type is a massive grey, hornblende granitoid rock. The next most common type is the pink variety, which in this pluton does not have a porphyritic facies.

One example of the grey type consists of hornblende laths measuring 4 mm by 3 mm with the feldspar occurring interstitially as white weathering areas. In thin section the rock shows hypidiomorphic-granular texture. Quartz is absent in this example, the major minerals being plagioclase and hornblende. The plagioclase is saussuritized, and clear parts of grains are albite (An_2). The hornblende occurs as subhedral and anhedral poikilitic grains, pleochroic in shades of pale yellow, pale green, and pale brown, and enclosing grains of altered feldspar, epidote, magnetite, leucoxene and ilmenite. Accessory minerals are apatite, magnetite and ilmenite. The mode of this rock is given in column 6 of Table 22. Because of the altered nature of the feldspar the rock cannot be accurately named but may be syenodiorite or diorite in the classification of Ayres (1972).

The pink type has a lower colour index and shows quartz on the fresh, but not the weathered surface. It is massive and medium-grained, and consists of interlocking white and pale buff grains of feldspar as irregular grains accompanied by dark green irregular grains of hornblende and less common biotite. In thin section the rock shows dusky anhedral grains of quartz with sutured boundaries and wavy extinction, altered anhedral grains of orthoclase, and altered plagioclase (the composition of the least altered grains is albite, An_6). The major ferromagnesian mineral is pale green, pleochroic, anhedral hornblende with ragged terminations. Accessory minerals consist of opaque ilmenite, variably altered to leucoxene, apatite, zircon, hematite, and pyrite. The mode of this rock is given in column 7 of Table 22. Owing to the altered nature of the plagioclase the rock cannot be accurately classified but it may be trondhjemite or quartz diorite in the classification of Ayres (1972).

Mafic Intrusive Rocks (Matachewan Type)

The Matachewan-type mafic intrusive rocks occur as diabase dikes most of which are 30-45 m wide and trend about N15W. Some of the dikes can be traced intermittently for dis-

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tances of up to about 200 m. The best exposed dike is that along the Ontario Hydro transmission line in eastern Natal Township. This dike is regarded as part of a dike collinear with it in northwestern Tyrrell Township (Carter 1977b).

The characteristic rock type is a dark green, dark grey, or black, medium-grained rock on the fresh surface, which weathers to a rusty brown surface showing well developed ophitic texture in most cases. The rock is always magnetic and in many cases strongly so. The rock type from the dike on the Ontario Hydro transmission line in southeastern Natal Township is medium grained, dark green and shows rude ophitic texture on the weathered surface. In thin section it shows subophitic texture consisting of a plexus of randomly oriented lath-shaped grains of plagioclase, most of which are saussuritized and partly enclose equant grains of augite which are surrounded by interstitial areas of micropegmatitic, quartz, chlorite and opaque, rectangular, and polygonal grains of magnetite. A few of the plagioclase feldspar laths are fresh, and these are labradorite (An_{56}).

Fine-grained to aphanitic diabase is usually black, consisting of grains 0.5 mm or less. Such diabase forms the chilled edges of the dikes.

Porphyritic diabase is similar, but is black in colour and contains subrounded phenocrysts of yellow sericitized feldspar measuring from 10 mm by 8 mm to 22 mm by 17 mm. These rocks are not common.

Leucodiabase is diabase which has a colour index of about 20. They appear as medium-grained, mottled black and grey rocks.

Granophyric diabase is medium to fine-grained, and shows irregular and interstitial dark red patches of micropegmatite.

MIDDLE PRECAMBRIAN

Huronian Supergroup

COBALT GROUP

Gowganda Formation

Within the map-area, sedimentary rocks of the Cobalt Group belong to the Gowganda Formation and are exposed in the east-central and northeastern corner of Natal Township and in most of central and southeastern Knight Township.

Argillites comprise an important lithological unit in the sequence and are best exposed in Knight Township where they are ubiquitous. The commonest type is a massive, black, aphanitic rock devoid of any stratification. The hardness of these rocks is less than 6 on Moh's scale. Some of the argillites are maroon in colour.

Slate is an uncommon rock type and is restricted to areas where a strong photo-lineament is apparent on air photographs. These rocks were observed in east-central Knight Township where the northern end of Metikemedo Lake connects with West Montreal River. Here the slates are associated with a north-trending photo-lineament and a north-trending reach of the river. The rocks are aphanitic, dark greenish-black in colour and have a well-developed slaty cleavage which strikes north. They probably formed by dynamic metamorphism of mudstone associated with faulting or shearing, as they can be seen to grade into uncleaved mudstones nearby.

Siltstones are grey fine-grained rocks, thinly bedded, with separation planes 2 cm apart, and showing colour bands in shades of grey, 1 mm thick. These rocks are widely distributed throughout the map-area but do not form thick units. They occur mostly in Knight Township.

Wackes are dark greenish-grey, medium-grained rocks which are widely distributed within the map-area but are commoner in the eastern part of the map-area than the western. The rocks consist of equant grains of quartz and feldspar 0.5 mm across and rare chips of subangular and subrounded reddish brown jasper 0.5 by 1.5 mm set in a dark greenish matrix.

Arenites are pink, grey, greyish-white, yellow and pale reddish-brown, fine-grained rocks consisting predominantly of quartz and feldspar. The grain size of these rocks is remarkably uniform, the grains being usually less than 0.5 mm in maximum dimension. Coarser grained varieties are much less common. In the fine-grained rocks lithic components are rare. The fine-grained arenites are common in the map-area and are well exposed along the shores of Duncan Lake. Bedding is well developed and the rocks occur as thick bedded units 25-40 cm in thickness. In the coarser varieties, called pebbly arenites, lithic fragments are common and form the pebbles. These pebbles are angular to subangular, range from 2 mm to 10 mm in diameter, and consist mainly of pink granitic rocks. A few of the larger fragments are of quartz or feldspar. Medium-grained arkose resembling pink granitic rock occurs at an outcrop near the southwestern end of Brush Lake in southwestern Knight Township. The rock is light pink in colour, is massive and even-grained, and contains grains of feldspar and quartz 2-3 mm long. Dark green mafic minerals measuring 4 by 1 mm are scattered through the rock. In thin section the rock shows a clastic texture and consists of simple and composite grains of xenomorphic and subrounded grains of quartz showing wavy extinction, chalcedony, subhedral and anhedral microcline, perthite, orthoclase, and albite (An_1); and lithic fragments of dacite (microlites An_7), biotite-quartz arenite, actinolite schist, and biotite-quartz schist. Mafic minerals are in accessory amount and comprise chlorite, biotite, hornblende, rutile, sphene and apatite.

A reddish-brown quartz-hematite-arenite breccia unit (Photo 16) outcrops on an island in Duncan Lake 1.2 km south of the northern boundary of Knight Township. The breccia consists of angular fragments of arenite up to 25 cm long set in a quartz-hematite matrix, and angular fragments of vein quartz and hematite in a quartz matrix.

Interlayered siltstone-mudstone units are restricted to the eastern shore of Duncan Lake in Knight Township, and are best developed near the Knight-Tyrrell boundary. The rock is purplish and consists of beds 10-15 cm thick interlayered with arenite. The composite rock type resembles the mudstones but it is well layered, and consists of layers 1-2 mm



Photo 16. Outcrop of quartz-hematite-arenite breccia, Gowganda Formation, Duncan Lake, Knight Township.

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thick of alternating clay and fine silt size particles. They have the appearance of varved clays.

Orthoconglomerate occurs in the lower part of the Gowganda Formation in east-central Natal Township and within a band about 1.5 km east of Duncan Lake, in Knight Township. The orthoconglomerate consists mainly of subrounded and rounded clasts of quartz, granite and aphanitic volcanic rocks. These are set in a medium to coarse, sand-sized, dark-grey, wacke matrix. The clasts range in size from 3 by 2 mm to 22 by 15 mm. The framework is disrupted. Rocks with such a matrix are well developed along the Ontario Hydro transmission line in northern Natal Township but here the fragments are much larger measuring from 1 cm to 25 cm. In Knight Township the matrix can be of arkosic as well as of greywacke composition.

Paraconglomerate is best developed in the middle part of the Gowganda Formation sequence as exposed in the map-area. It is best exposed in the area east of Duncan Lake in Knight Township. The rocks differ from orthoconglomerate in that the clasts consist entirely of granitic rocks, widely separated from each other in a mudstone or shale matrix to form a disrupted framework (Photo 17). The matrix is never wacke or arenite. The clasts range in size from 0.5 to 90 cm, and are rounded.

Gravelly arenite is a pink and greyish white, matrix-supported rock consisting of granules of pink feldspar and pebbles and cobbles of quartz and pink muscovitic granitic rocks set in an arkosic matrix. The fragments range from 4 to 74 mm, the smaller grains consisting of feldspar. The feldspar granules are subangular to angular but the larger pebbles and cobbles are subrounded and rounded. The matrix consists of angular grains of quartz and feldspar 0.5 to 1.5 mm across.



Photo 17. Outcrop of paraconglomerate, Duncan Lake, Knight Township.

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Mafic Intrusive Rocks (Nipissing Type)

Nipissing-type mafic intrusive rocks occur primarily as an arcuate concave-eastwards sill about 200 m thick and dipping approximately 25 degrees east, in accordance with the Gowganda sedimentary rocks which it intrudes, in east-central Knight Township. This sill is regarded by the author as part of a cone sheet intrusion. These mafic rocks also occur as dikes trending N45E in southeastern Knight Township; as smaller north-trending sills in the Gowganda sedimentary rocks in east-central and eastern Knight Township; and as small isolated bodies overlying Early Precambrian metavolcanics, possibly as erosional remnants of a sill, in northeastern Knight Township.

Medium-grained diabase, which is the typical rock type, is a greenish-black or black massive rock on the fresh surface, and weathers to give a reddish brown rough surface. This weathered surface shows a coarse, crude, ophitic texture. In thin section the rock shows coarse ophitic to subophitic texture, consisting of fresh and altered brown saussuritized plagioclase (labradorite, An_{50}) and fresh, unaltered and chloritized augite forming a framework which encloses interstitial irregular grains of quartz, micropegmatite and graphic quartz-feldspar intergrowths. Opaque grains consist of magnetite or ilmenite. This rock type comprises most of the mafic rock forming the sills and dikes.

Coarse-grained diabase is less common and in hand specimen shows radiating amphibole and pyroxene grains measuring 10-15 mm long by 3 mm wide enclosing rudely equant grains of pale green feldspar and pyroxene 2-3 mm across. Coarse ophitic texture is visible on the weathered surface. A thin section from this rock shows a coarse subophitic texture formed by partially and completely unaltered augite and completely saussuritized plagioclase. The augite is altered to green and pale brownish actinolite, some of which is plumose, and pale brown biotite. In the alteration of augite to biotite, magnetite or ilmenite is released. Interstitial areas are occupied by coarse micropegmatite. Opaque minerals consist of irregular patches, stringers and subhedral grains of magnetite or ilmenite.

Fine-grained diabase is similar to the medium-grained type except that it is blacker in appearance and is of fresher aspect.

Leucodiabase is lighter coloured than the typical diabase and has a colour index of about 30. This rock type is medium grained and shows a megascopically granular texture. The rock is fresh and in thin section shows coarse subophitic texture in which largely fresh augite partly encloses relatively unaltered plagioclase (bytownite, An_{50}). The augite is in places wholly and partly unaltered to a brownish, fine, fibrous amphibole, and pale green and yellow chlorite. Some of the augite shows herringbone and exsolution structures. Interstitial micropegmatite and quartz are present. Accessory minerals consist of brown biotite, epidote and opaque magnetite or ilmenite.

STRUCTURAL GEOLOGY

Folding

EARLY PRECAMBRIAN METAVOLCANICS AND METASEDIMENTS

The metavolcanics and metasediments are folded about a plunging synclinal axis located in Natal Township, the axial trace of which trends N50-60W diagonally across the township. In the northwestern part of the township the axial trace trends generally northward, and the plunge is about 20 degrees northwesterly. Rocks in northeastern Natal Township and in Knight Township are on the northeastern limb of the syncline, whilst those in southwestern Natal Township are on the southwestern limb. The rocks are steeply dipping, the dip varying from 35 to 85 degrees, but most dips are in the range 60 to 85 degrees. Structural evidence used in determining the fold structure included graded bedding, shape of pillow structures, and the coincidence of photo-lineaments with lithological trends.

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HURONIAN SEDIMENTARY ROCKS

Abundant structural data and the occurrence of graded bedding and bedding laminations indicate that the Huronian sedimentary rocks in Knight Township form a gently curving, arcuate, concave-eastwards, homoclinal sequence dipping and younging eastwards. In the vicinity of Pigeon Lake, in the northwestern part of Knight Township the rocks are tightly folded about north-trending axes, probably due to faulting. The dip ranges from 5 to 55 degrees but the majority of the readings are in the range 20 to 35 degrees. In Natal Township structural data are scarce; dips of 14N, 30N, and 90 degrees were recorded in the north-eastern corner.

NIPISSING-TYPE DIABASE

The Nipissing-type diabase forms a gently curving, concave-eastwards, diabase sill enclosed in Huronian sedimentary rocks and dipping concordantly with these at about 25 degrees east. This sill is probably part of a cone-sheet structure centred east of the map-area.

Faulting

Two major faults cross the map area diagonally. They are the Natal Lake Fault in south-central Natal Township and the Pigeon Lake Fault in southcentral Knight Township. Natal Lake Fault trends N45W, and Pigeon Lake Fault N35W on average, making the two faults sub-parallel. Insufficient evidence occurs in the map-area to indicate the type of faulting, but west of the northwestern corner of Natal Township, in Kelvin Township, a marked fault scarp exists on the northeastern side of Upper Grassy Lake, which occupies the extension of Natal Lake Fault. The area to the west is lower, suggesting a downthrow to the west. The fault is thus regarded as a possible gravity fault.

A set of faults and photo-lineaments, trending generally north, cross the map area from the eastern third of Natal Township to eastern Knight Township. Those in Natal Township are considered to be gravity faults with downthrow to the east, as the Middle Precambrian Huronian rocks which they cut are preserved on the eastern part of the faults but are entirely absent on the immediate western part of the faults except where such faults are close together. In the latter case the Middle Precambrian rocks are preserved between the faults implying a local graben structure and thus gravity faulting.

ECONOMIC GEOLOGY

History of Exploration

Recorded exploration activity in the map-area began in 1930 in Knight Township, and in 1945 in Natal Township. This continued up to 1967 in Natal Township, but extended up to 1971 in Knight Township, with a lull in activity there from 1940 to 1943. Exploration in Knight Township was carried out primarily for gold in the early years, but later, from 1965, nickel was actively sought. In Natal Township exploration activity was mainly for copper.

The first recorded exploration work was for gold, and was carried out in 1930 by McIntyre Porcupine Mines Limited who trenced a metavolcanic-granodiorite contact on their nine-claim property in the southwestern part of Knight Township at the northern end of McIntyre Lake. Part of the property was later trenced by a Mr. Duggan in 1937, and later diamond drilled in 1938, when 13 holes totalling 586 m were put down.

In 1931, the L.O. Hedlund property, 1.6 km to the east of the former McIntyre Porcupine Mines Limited property, Knight Township, was staked by L.O. Hedlund and optioned

to J.C. Waite and later to M.J. O'Brien. Extensive trenching and diamond drilling for gold were carried out on the property which extends into Tyrrell Township to the south. In 1936 it was taken over by Tyrannite Mines Limited who sank a three-compartment shaft in Tyrrell Township to the south, where all major development was carried out.

In 1931, C.F. Hurst discovered gold, molybdenite, pyrite and chalcopyrite near the southern end of Pigeon Lake, Knight Township on property now held by Wahbic Explorations Limited. In 1938, the property was mapped by Erie Canadian Mines Limited.

In 1933, D.H. Gardner discovered gold in the area east of Arthur Lake, southwest Knight Township. The showings were later examined by Erie Canadian Mines Limited in 1939. Work was resumed in 1959 when Courageous Gold Mines Limited diamond drilled 17 short holes for a combined length of 408 m. Further diamond drilling amounting to 329 m in five holes was carried out by New Senator-Rouyn Limited in October of 1964.

In the period 1935-1937, Erie Canadian Mines Limited carried out trenching and a detailed examination of properties in the vicinity of Brush Lake, in the southwestern part of Knight Township where gold had been discovered in 1935 by J.B. Moyneur. Thirty years later, in 1967, Timiskaming Nickel Limited diamond drilled two holes on the shore of the lake for a total length of 225 m.

In 1939, L.L. Coullis carried out trenching and pitting on his property, now held by Guaranty Trust Company of Canada, for silver on the shore of Duncan Lake near the northern boundary of Knight Township.

In the same year, 1939, Hollinger Gold Mines Limited extensively trached three claims held by A. Decker in the southwestern corner of Knight Township, 400 m northwest of Moon Lake, for gold. Later, in the period 1944-1945, Camdeack Gold Mines Limited diamond drilled 22 holes for a total length of 625 m on the property. This was followed by the diamond drilling of nine holes totalling 764 m by Becrite Mines Limited in 1950. Then, eight years later in 1958, Wexford Mines Limited diamond drilled five holes totalling 150 m in the same area and, in 1965, Initiative Explorations Limited drilled six holes totalling 807 m. In all, 42 diamond drill holes were put down in this area in the search for gold. No economic deposits were located.

In 1945, the earliest year of recorded exploration activity in Natal Township, A. Fuller diamond drilled 12 holes amounting to 433 m in the southeastern corner of the township in breccias and trachyte flows for gold.

In 1948, McIntyre Porcupine Mines Limited carried out blasting, trenching and geological mapping of a set of showings in northeastern, northwestern and east-central Natal Township where chalcopyrite was found in quartz veins in Early and Middle Precambrian rocks. In 1956 Lucky Creek Mining Company Limited sank two pits on one of these veins. No economic deposits were located.

The discovery of nickel in ultramafic rocks at Arthur Lake in southwestern Knight Township in 1965, by A. Decker, led to considerable exploration activity for nickel deposits in the ensuing years. This work began in 1966 when W.D. Sutherland and Associates diamond drilled nine holes for 1950 m at Arthur Lake and to the north of it, for nickel mineralization. This was followed by the drilling of 12 diamond drill holes for 1715 m by Arthur Lake Mines Limited at the same lake in 1967. In the same year Timiskaming Nickel Limited drilled five diamond drill holes for 972 m, 1.2 km southeast of Arthur Lake in ultramafic rocks, and one hole for 185 m, 0.2 km southwest of the lake. Following this, the same company, early in 1968, diamond drilled 14 holes totalling 1689 m, 2.4 km southeast of Arthur Lake in the vicinity of an asbestos showing in ultramafic rocks. Later in the year this same company retained Huntlec Limited and Lockwood Survey Corporation to carry out airborne magnetic and electromagnetic surveys over the western half of Knight Township where ultramafic rocks are exposed. No major anomalies were discovered.

In 1966, Whitegate Mining Company Limited diamond drilled two holes, totalling 382 m, and in 1967, two further holes totalling 316 m, on their property near the southern end of Pigeon Lake in an area underlain by ultramafic rocks, probably for nickel. In 1968 Wahbic Explorations Limited diamond drilled three holes totalling 497 m on their property at the

NATAL AND KNIGHT TOWNSHIPS

southern end of Pigeon Lake, Knight Township, in ultramafic rocks apparently for nickel mineralization. Finally, in 1971, Amax Potash Limited carried out a vertical electromagnetic survey on their property at Pigeon Lake, outlining a 1200 m conductive zone. Later ground magnetometer work revealed two areas inferred to be underlain by mafic and ultramafic intrusive bodies. Geological and geochemical surveys were subsequently conducted in 1972 to check the inference. No further work was recorded.

In 1966, W.D. Sutherland diamond drilled four holes for a total of 456 m, 1.2 km east of the southern end of Arthur lake on property now held by Metikemedo Mines Limited, apparently for gold.

In 1967, W.D. Sutherland carried out a magnetometer and electromagnetic survey on a group of claims owned by Tallman Mines Limited on the west-central boundary of Natal Township. Several weak anomalies were located.

CHARACTER OF DEPOSITS

The deposits of the map-area are concordant and discordant vein-type deposits of copper, silver, gold and asbestos, and concordant stratabound nickel deposits associated with ultramafic rocks. The deposits occur within Early Precambrian ultramafic rocks, mafic to felsic metavolcanics, granitoid rocks and diabase dikes, and within Middle Precambrian sedimentary and mafic igneous rocks.

Deposits Associated with Early Precambrian Metavolcanics

CONCORDANT STRATABOUND NICKEL DEPOSITS

Stratabound nickel deposits are represented by the deposit on the property of Arthur Lake Mines Limited. The deposit is associated with northwesterly trending ultramafic rocks, and is described as consisting of sooty and crystallized disseminated pentlandite in a breccia unit, known locally as 'deckerite', in concordant ultramafic rocks. The rocks trend N30W and the breccia unit was described in the company reports to be up to 240 m wide. The mineralization is regarded by the author as primary and associated with komatiitic volcanism, as the deckerite is regarded as an ultramafic lapilli tuff. The best assay from drilling in such rocks was 0.88 percent Ni over 1.2 m (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake).

CONCORDANT GOLD VEIN DEPOSITS

Concordant gold vein deposits comprise mineralized shears and fractures which trend north, roughly parallel to the trend of their Early Precambrian metavolcanic host rocks. These are exemplified by (1) the gold deposits, examined by Timiskaming Nickel Limited, northwest of Moon Lake in southwestern Knight Township; (2) the Metikemedo deposit about 1.2 km east-southeast of Arthur Lake; and (3) the Hurst deposit about 0.4 km north-east of the southern end of Pigeon Lake. All of these are in Knight Township. The gold occurs in quartz veins in shears in alkalic rocks in the first occurrence and in mafic metavolcanics in the other.

DISCORDANT VEIN DEPOSITS

Copper

A set of short quartz veins trending on average N80-85E occupies a zone about 1.5 km wide trending N80-85E and parallel to a line joining Little Pigeon and Segantiu Lakes in northern Natal Township. This trend is markedly discordant with the axis of folding in the

area which is N35W. No shearing or alteration in veins or wall rocks enclosing the veins was observed by the author or reported by companies. These veins are regarded as fissure veins occupying shear joints and related to the folding in the Early Precambrian rocks. The deposits are not obviously related to any intrusive granitic body, and may be of volcanic origin.

Asbestos

Asbestos occurs as irregular, ramifying veins and stringers of soft cross fibre asbestos in black serpentinite. The serpentinite unit is concordant with the regional structure, and may be extrusive.

Deposits Associated with Early Precambrian Granitoid Rocks

VEIN-TYPE GOLD DEPOSITS

Within the Milly Creek granitoid pluton, in the southwestern part of Knight Township, mineralization occurs at three places: (1) the north end of McIntyre Lake near its western contact with mafic metavolcanics; (2) 400 m east of Spade Lake near its eastern boundary with Cobalt sedimentary rocks; and (3) at a promontory on the northern shore of Pigeon Lake, at the southern end of the lake, near the northern contact of the pluton.

At the north end of McIntyre Lake the gold occurs in quartz-carbonate veinlets in fractures oriented N40W and N15W at the contact of "granodiorite and greenstone" (Graham 1932, p.57). The "greenstone" is regarded by the author as a large xenolith of mafic metavolcanics in the granitoid rock. The mineralized zone itself trends N10W.

East of Spade Lake, gold occurs in a fracture zone trending N10W, parallel to the contact of granitoid rocks and a basaltic xenolith enclosed in the Milly Creek Pluton.

At the northern end of the Milly Creek Pluton, gold and molybdenite occur in a quartz vein, the Hurst deposit, striking N08E in fractured granodiorite.

Deposits Associated with Matachewan-Type Diabase Dikes

UNCLASSIFIED COPPER DEPOSITS

In southeastern Natal Township about 1.2 km south of the central part of Natal Lake, an occurrence of copper in a north-northwesterly trending diabase dike was observed. The copper occurs as malachite staining on ramifying quartz-calcite veining, the trend of which could not be determined. Many of these dikes show considerable epidote alteration, e.g. the dike along the east shore of Natal Lake. As these dikes may range in age from Early to Late Precambrian — similar trending dikes were observed to cut Gowganda Formation rocks in Leonard Township (Carter 1977a, Map 2369) — and as silver is associated with the diabase cutting the Middle Precambrian sedimentary rocks, these diabase dikes may contain copper and silver mineralization.

Deposits Associated with Middle Precambrian Gowganda Sedimentary Rocks

DISCORDANT VEIN-TYPE COPPER-COBALT DEPOSITS

Structural data in Knight Township indicate that the rocks of the Gowganda Formation trend north-northeasterly in the northern part of the township, northerly in the central part, and north-northwesterly in the southern part, to form a slightly concave-eastwards arcuate pattern. This may be the case also in Natal Township, but structural data are absent there. With respect to this trend, the mineralized veins in northern Knight Township (Duncan Lake occurrence) and northern Natal Townships (McIntyre Porcupine Mines Limited) are discordant.

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dant. A characteristic feature of these quartz veins is the common occurrence of specular hematite with the copper.

STOCKWORK COPPER-BEARING QUARTZ VEINS

A convincing example of a quartz stockwork containing copper is the Sommerville occurrence in south-central Natal Township. The stockwork consists of a rectangular network of quartz veins ranging from 2 cm to 1 m wide, in remarkably mature arenite.

Deposits Associated with Nipissing-Type Diabase

CONCORDANT VEIN-TYPE SILVER-GOLD DEPOSITS

Nipissing-type diabase occurs mainly as a concordant gently-curved concave-eastwards sill in the Gowganda Formation in east-central Knight Township, and as northeasterly trending dikes in southeastern Knight Township. The most important silver deposit is the Coulie vein system (Guaranty Trust Company of Canada property) which consists of two intersecting veins, the more prominent of which is concordant with the trend of the sill.

UNCLASSIFIED COPPER DEPOSITS

Because of poor exposure, copper deposits in the Duncan Lake diabase sill in the southern part of Knight Township (Duncan Lake occurrence) and in the northeast trending dikes in southeastern Knight Township (Polliwog Lake occurrence) cannot be classified on the basis of their relative trend with respect to the sill and dikes respectively.

Recommendations for Future Mineral Exploration

ASBESTOS

Asbestos occurs in the map-area associated with ultramafic rocks. Because of the known association of asbestos with such rocks, it is recommended that prospecting activity for this material be concentrated in southwestern Knight Township where ultramafic rocks are best developed.

COPPER

Copper occurs as chalcopyrite most commonly with east-trending quartz veins associated with a zone of fracturing in Early Precambrian rocks in the Little Pigeon Lake - Seganku Lake area. This area contains the greatest concentration of veins and would represent the most promising location for the discovery of economic copper deposits.

Copper as chalcopyrite is also associated with the Nipissing-type diabase, but these occurrences are of lesser importance.

GOLD

Gold occurs in quartz veins, quartz-carbonate veins and shears in Early Precambrian alkalic metavolcanics and granitoid rocks. Such alkalic metavolcanics are well exposed in southeastern Natal Township and the search for gold should be concentrated in this area in regions where the rocks are sheared and fractured. Granitoid rocks occur in two areas: south-central, and northeastern Knight Township. Mineralized zones should be sought for

in fractured regions associated with basalt xenoliths, within the plutons. Two such zones trend N10W in the pluton in south-central Knight Township and these shearing directions may be significant for gold mineralization.

NICKEL

Nickel deposits in the area are clearly related to the komatiitic ultramafic rocks. As these rocks have been shown to be associated with a high degree of nickel mineralization (Naldrett and Cabri 1976, p.1142) the area underlain by such rocks in southwestern Knight Township is strongly recommended for nickel prospecting.

SILVER-COBALT

Although silver-cobalt mineralization is not widespread in the map-area, this type of mineralization is clearly associated with the Nipissing-type diabase sill which intruded into Middle Precambrian sedimentary rocks. The deposits occur within the diabase or in Middle Precambrian sedimentary rocks near the contact with diabase. No special characteristics of the diabase associated with the mineralization were noted, except that the diabase was medium-grained.

Description of Properties, Deposits, and Explored Areas

NATAL TOWNSHIP

ARTHUR LAKE MINES LIMITED (1)

See "Arthur Lake Mines Limited" under Knight Township.

ECSTALL MINING LIMITED (2)

In 1974 Ecstall Mining Limited held two contiguous unsurveyed claims in southeastern Natal Township along the east shore of West Montreal River above Elbow Rapids.

No assessment work is filed for the property but near the southeastern end of the property a white calcite vein 1 m wide and 1.5 m long occurs in sheared dark green basalt. The vein strikes N55E and dips 85 degrees west. This calcite vein contains about 15 percent disseminated chalcocopyrite in grains 3 mm across and in irregular stringers 2 mm wide. The West Montreal River in this area follows a fault striking N05W and it is believed by the author that the vein occupies feather joints associated with this fault.

A. FULLER (1945) (3)

A. Fuller held a group of 10 contiguous claims in southeastern Natal Township in 1945. The claims have since been allowed to lapse.

Twelve diamond drill holes were put down, apparently in 1945, for a total length of 433.1 m on two of the claims. The property was visited in 1945 by the Resident Geologist at Kirkland Lake, J.W. McBean, in order to log the core and construct a location map. Core logging indicated that the "drilling was carried on entirely in trachyte flows and breccias. Several brecciated quartz veins 2 to 3 inches in width were noted in bleached and slightly altered trachyte breccia. No mineralization was observed." (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). Current mapping has indicated that the holes were collared entirely in mafic alkalic flows.

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MCINTYRE PORCUPINE OCCURRENCES (4)

These showings occur on the former McIntyre Porcupine Mines Limited property which consisted of 26 contiguous claims staked in 1948 and located east of Seganku Lake in northeastern Natal Township. The claims were allowed to lapse.

Exploration work consisted of geological mapping, trenching and blasting, all of which was carried out in 1948.

Two occurrences are referred to as the No.6 and No.7 veins in the company report (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). No. 6 vein was not visited during the current mapping but it is located about 1.2 km southeast of the southeastern end of Seganku Lake. It was described in the company report as a vein apparently "located along a N-E fault zone... along the east face of a fault scarp. The vein is not continuous but appears over a length of 270 feet and has a maximum width of 13 feet. Chalcopyrite was noted in the vein mainly along the N-W wall. Some blasting was done here" (Resident Geologist's files, Kirkland Lake). The vein is shown as intersecting Cobalt conglomerate in the company report. The best assay result from an unknown type of sampling in a vertical cut of the quartz returned 0.28 percent Cu over 1.4 m. No. 7 vein is located about 1.5 km east-northeast of the northeastern end of Seganku Lake and was visited during the current mapping. It consists of a quartz vein 1.5 m wide and about 11 m long which strikes N80E and dips vertically. The quartz vein occurs in arkose and paraconglomerate of the Gowganda Formation and is mineralized with chalcopyrite showing alteration to malachite, specular hematite, and pyrite occurring as patches in the quartz. The showing has been blasted and trenched. The best assay from an unknown type of sampling from a blasted area returned 0.06 percent Cu over a 0.3 m width of cut (Resident Geologist's files, Kirkland Lake).

NABIGON, P. (5)

In 1974 P. Nabigon held nine unsurveyed claims stretching southwards from the southeastern part of Seganku Lake in northeastern Natal Township. These claims cover part of the former McIntyre Porcupine Mines Limited property and the eastern group of claims of the Lucky Creek Mining Company Limited property held in 1956.

Two composite vein systems occur on the property, the more northerly is called in this report the McIntyre vein, and the more southerly the Buffalo-Ankerite vein. Both these vein systems were described in the company report on the McIntyre Porcupine Mines Limited property (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake), but were not visited during the present survey.

The McIntyre vein was described in the company report as consisting of "short narrow lenses of quartz in conglomerate and arkose formation". They vary from 10 to 40 cm in width and from 2.5 to 11 m in length, "strike from slightly north of east to slightly south of east and dip from 79° north to vertical" (Resident Geologist's files). Only minor amounts of chalcopyrite were noted, the best assay from an unknown type of sampling returned 0.25 percent Cu over a 25 cm width of cut in quartz (Resident Geologist's files). Current mapping by the author, however, shows that the area is underlain by metavolcanics.

The Buffalo-Ankerite vein "consists of quartz veins and stringers over a maximum width of 19 feet and exposed in 4 spots for a possible length of 206 feet. The vein strikes somewhat north of east and dips vertically. The wall rock is massive, fine grained quartzite" (Resident Geologist's files). The best assay result from an unknown kind of sampling of blasted quartz was 1.28 percent copper over a width of cut of 0.9 m (Resident Geologist's files).

NATAL LAKE COPPER OCCURRENCE (6)

About 1.2 km south of the central part of Natal Lake in southeastern Natal Township, an oc-

currence of copper as secondary malachite was observed during the current mapping. The malachite occurs as staining on ramifying quartz-calcite veining in diabase. A trench 2.4 m by 0.6 m by 0.9 m was observed at the showing, but there is no reference to this work in the assessment work files.

SOMMERVILLE COPPER OCCURRENCE (7)

The Somerville copper occurrence is located about 1.2 km north of the eastern end of Natal Lake in southeastern Natal Township, and was located and examined during the current survey.

The showing consists of a stockwork of quartz veins trending N60E and N30W on average. The veins trending N60E were better developed. These veins range from 2.5 to 90 cm in width and the longest exposed vein was 12 m. The veins are in white and light cream coloured arenite of the Gowganda Formation and were mineralized with disseminated chalcopyrite as grains 2 mm in diameter, some of which are altered to malachite. Some of the veins were sampled by McIntyre Porcupine Mines Limited in 1948 and the best assay result from an unknown type of sampling was 0.13 percent Cu over a 0.6 m width of cut (Resident Geologist's files, Ontario Ministry Natural Resources, Kirkland Lake).

W.D. SUTHERLAND AND ASSOCIATES [1966] (8)

In 1966 W.D. Sutherland and Associates held 19 claims in southeast and northeast Natal Township and southwest Knight Township. These claims were not in good standing in 1974.

In 1966 two diamond drill holes totalling 414.3 m were drilled on a claim in northeast Natal Township at the boundary with Knight Township. Andesite, rhyolite, diorite, 'hen-track' tuff, and an olivine diabase dike were intersected. Carbonate stringers and seams were present, but no mineralization was encountered.

TALISMAN MINES LIMITED [1967] (9)

Talisman Mines Limited held a contiguous group of 27 claims straddling the Kelvin-Natal Townships boundary in 1967. These claims were allowed to lapse.

Ground magnetic and electromagnetic surveys were carried out on the property in 1967. The former indicated northwest trending anomalies in the northeastern part of the claim group which lies in Natal Township. It was considered by the company geologist that the anomaly in Natal Township could be due to a diabase dike as was suggested on geological Map 35j (Gledhill 1927). Current mapping indicated that a diabase dike trending north-northwesterly is present in the area of this magnetic anomaly. Only marginal electromagnetic responses were obtained. It was concluded that drilling was not warranted, and no further work was recorded for the area.

TIMISKAMING NICKEL LIMITED [1967] (10)

In 1967 Timiskaming Nickel Limited held 191 claims in the eastern part of Natal Township. These were not in good standing in 1974.

In the northeastern part of the township the company drilled eight diamond drill holes in 1967 for a total of 1098 m on the property. The reason for this drilling was not given but it is believed that it was carried out to test in part the fault zone which is followed by the West Montreal River in this reach of its course. Six of the eight holes were collared in Early Precambrian rocks, and two in Middle Precambrian Cobalt sedimentary rocks. The six holes in Early Precambrian rocks intersected 'deckerite', 'hen-track tuff', diabase, hornblende tra-

NATAL AND KNIGHT TOWNSHIPS

chyte, diorite and rhyolite. Mineralization consisted of disseminated pyrite, pyrrhotite, and arsenopyrite. The two holes which were drilled into Gowganda Formation rocks encountered argillite, arkose, conglomerate, and diabase. No economic mineralization was reported.

WHYTE, A. (11)

In 1974, A. Whyte held a group of 20 contiguous unsurveyed claims in northwestern Natal Township stretching from Little Pigeon Lake to the western end of Seganku Lake. This property enclosed the former western group of claims of the Lucky Creek Mining Company Limited. Several quartz veins occur on the property and some of these had been described and prospected by J.W.B. Bonnell for McIntyre Porcupine Mines Limited in 1948. Some of these showings were also visited during the current survey.

One of the veins, known as the Miller showing, is referred to here as the Miller vein. It is located 0.4 km west of the northwest corner of the western end of Seganku Lake. It is described by McIntyre Porcupine as a "quartz vein with a maximum width of 15' exposed in three pits for a length of 110'. The vein strikes slightly north of east and dips vertically. The quartz is massive and bullish with only a trace of chalcopyrite. The wall rock is greywacke, which is unsheared and unaltered" (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). The company geologist thought the vein was the extension of the No. 7 vein of the McIntyre Porcupine occurrence. The best assay result from an unknown type of sampling in 1948 was 0.19 percent Cu over 1.9 m width of cut from blasted quartz (Resident Geologist's files).

A set of subparallel veins trending approximately N80E, occurring at the west end of Little Pigeon Lake, were collectively referred to as the Teegama showings (Resident Geologist's files). Some of these were pitted and assayed but the specific veins cannot be accurately located. These latter are described as quartz "veins and stringers. . . exposed over a length of 2300 feet but do not appear to be on strike" (Resident Geologist's files). The dip was recorded as varying from 46 degrees north to vertical. "Individually the veins vary in width from a few inches to 17 feet and are exposed for a maximum length of 35 feet. The quartz is fractured looking and in spots shows approximately 5-10% chalcopyrite. The wall rocks are greywacke, arkose and quartzite. Little shearing or alteration was noted" (Resident Geologist's files). Six pits were put down on the veins and the best assay result was 1.5 percent Cu over 0.8 m width of cut from quartz (Resident Geologist's files).

During the current mapping, various quartz veins, some of which had been pitted and trenched, were located around the shore of Little Pigeon Lake and to the northwest of the western end of the lake. No shearing or alteration was observed in the wall rocks. The trend of all these veins was approximately east. A grab sample was taken by the author from two of these veins which showed disseminated chalcopyrite occurring as patches about 3 by 4 mm, and assayed for copper. Assay results were 0.44 percent and 0.68 percent copper (assays by Geoscience Laboratories, Ontario Geological Survey, Toronto).

KNIGHT TOWNSHIP

AMAX POTASH LIMITED [1971] (12)

In 1971 Amax Potash Limited held four unsurveyed contiguous claims in southwestern Knight Township along the northeastern shore of Pigeon Lake. The claims were not in good standing in 1974.

Current mapping shows that the claim group is underlain by ultramafic, mafic, and intermediate metavolcanics trending N40W. These are unconformably overlain by argillite and orthoconglomerate of the Gowganda Formation in the northeastern corner of the claim group.

A ground magnetometer survey was carried out in 1971 by Amax Potash Limited which "revealed the presence of two zones of high susceptibility trending in a N-S direction which can confidently be inferred to reflect the presence of mafic and ultramafic intrusive bodies" (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). A ground geophysical Radem survey was also carried out and a 1200 m conductor was located. However, this conductor did not coincide with any of the magnetic anomalies. Analysis of drill core found on the property by the company geologist and found to contain graphite returned assays of "... 0.05% Cu, 0.23% Zn and 0.22 oz. Ag/ton. A 25 foot section of serpentinite from the core yielded only very weak nickel values (0.03% Ni)" (Resident Geologist's files). Geological and soil geochemical surveys were subsequently carried out by the company in 1972. The geological survey indicated a "complex of Archean metavolcanic units ranging in composition from basalt to dacite... intruded by gabbroic and peridotitic masses. Unconformably overlying these units is a sequence of Huronian sediments... consisting of quartzites, arkose, and conglomerate" (Resident Geologist's files). It was concluded from the geochemical results that it would be "tenuous to attribute the source of the geochemical features present on the property to the outlined conductor..." (Resident Geologist's files). Because of these results the "geological and geochemical response... were considered not to warrant drilling" (Resident Geologist's files).

ARTHUR LAKE MINES LIMITED (13)

In 1974 Arthur Lake Mines Limited held three surveyed claims in Knight Township numbered MR 43102, 43107, and 43108 on the eastern half of Arthur Lake in the southwestern part of the township, and two unsurveyed claims on the northwestern part of the same lake in southeastern Natal Township. These claims formed a contiguous set of five claims and were part of a much larger group of claims held in 1967 and straddling the Natal-Knight boundary near Arthur Lake. The property includes the area where nickel was discovered by Albert Decker of Gowganda, Ontario, in July 1965. The discovery was optioned to W.D. Sutherland and Associates in October 1965, and later to Arthur Lake Mines Limited, a company formed to explore the occurrence.

The discovery was reported to consist of pentlandite in ultramafic rocks on the northwesterly projecting peninsula in the northeastern corner of Arthur Lake. The pentlandite was described in the company report as occurring as "sooty disseminations" (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). The fragments were said to range in size from "a few millimeters to two inches across" (Resident Geologist's files). The pentlandite occurred in the tuff fragments and as "tiny clusters of needle shaped crystals on chlorite slip planes in the tuff" (Resident Geologist's files). The deckerite unit was said to be up to 240 m wide with a general strike of north to N15W and a dip in one place of 68 degrees west. The rock type was reported to underlie the lake and to occur on both the east and west shores.

Twenty diamond drill holes for a total length of 3434.5 m were drilled at Arthur Lake to test the mineralization. W.D. Sutherland and Associates drilled seven holes for 1535 m in 1966, Arthur Lake Mines eight holes for 1148 m in 1967, and Timiskaming Nickel Limited five holes for 751.9 m in 1967. Rocks encountered in the core from drilling by W.D. Sutherland and Associates were reported to be andesite, rhyolite, deckerite, hen-track tuff, hen-track porphyry, diorite, diabase, porphyry, and aplite and monzonite as dikes. Altered zones containing quartz, carbonate and chlorite, were also intersected. Mineralization consisted of pyrite, pyrrhotite, chalcopyrite, and sphalerite. Nickel was reported from assay results, the best assay being 0.88 percent Ni over 1.2 m (Resident Geologist's files). Gold, silver, copper and zinc were also present: the best assay for gold was 0.03 ounces per ton, and for zinc was 0.65 percent over unknown widths (Resident Geologist's files). Examination of core at the property by the author showed pyrite to occur as nodules and globules up to 2 cm in diameter in graphite. Rocks encountered in the drilling by Arthur Lake Mines

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Limited were 'deckerite', rhyolite, dacite, andesite, tuff, tuff-breccia, diabase, arkose, gray-wacke, hen-track tuff, lamprophyre, quartz porphyry and graphite. Carbonate, and quartz-carbonate alteration zones were intersected in the drilling. Mineralization consisted of fine-grained and nodular pyrite, arsenopyrite, and mariposite. The best assay result for nickel was 0.96 percent Ni over 1.5 m of 'deckerite' (Resident Geologist's files). During the drilling by Timiskaming Nickel Limited 'deckerite' was encountered predominantly throughout most of the holes, with lesser amounts of andesite, trachyte, and interflow sedimentary rocks. Alteration zones consisted of carbonate and quartz-carbonate. Mineralization consisted of pyrite, arsenopyrite and mariposite. The best nickel assay from this drilling was 0.46 percent Ni over 1.5 m (Resident Geologist's files).

COURAGEOUS GOLD MINES LIMITED [1959] (14)

In 1959 Courageous Gold Mines Limited held 12 contiguous, unsurveyed claims at the southeastern corner of Arthur Lake in Knight Township. These claims were not in good standing in 1974.

In 1959 this company drilled 17 holes on its property for a total of 408 m. Fifteen of the holes are located on what is now the property of Metikemedo Mines Limited, and two are on open ground at the southern shore of Arthur Lake in Knight Township. The two holes at Arthur Lake totalled 63.7 m and encountered quartz and green carbonate zones, rhyolite, porphyry, and andesite with pyrite mineralization. No assay data are recorded for the drilling.

DALHOUSIE OIL COMPANY LIMITED (15)

In 1974 Dalhousie Oil Company Limited held three surveyed claims numbered GG 6649, 6650, and 6651 at McIntyre Lake near the middle part of the southern boundary of Knight Township. The claims form part of the original block of 27 claims straddling the Knight-Tyrrell Townships boundary and staked by E. Holland in 1930 for McIntyre Porcupine Mines Limited (Graham 1932, p.57).

In 1931, 300 m of trenching and rock cutting were carried out on the deposit located on claim GG 6649 at the northern end of McIntyre Lake and called the "main" deposit. This was described as follows by Graham (1932, p.57):

"The main deposit was formed in local fracturing at the contact of the granodiorite (and greenstone). There are two directions in which local fracturing is most decided. These are N40° and 15°W. Mineralization occurred over an area approximately 300 feet long and 60 feet wide. The fractured granodiorite and greenstone were replaced partially by quartz and pyrite. Quartz carbonate veinlets, containing small amounts of pyrite, chalcopyrite, and arsenopyrite, occupy many of the fractures. Visible gold was detected in veinlets intersecting the granodiorite, and samples of this material yielded the best assay values. The channel sampling of the mineralized zone indicated a low-grade deposit."

The zone was later trenched in 1937 by a Mr. Duggan, and in 1938, 13 holes were diamond drilled for a total of 596 m. Assay values from the trenches were shown on plans but the units of measurement are not stated.

A. DECKER (16)

In 1974 A. Decker held one unsurveyed claim L 367732 (formerly the surveyed claim GG 6080) in Knight Township, 0.4 km north of the middle part of the southern boundary of the township.

No assessment work has been filed for this claim but it contains the northern part of the gold-bearing fracture zone which formed the Tyrannite mine and current mapping shows it to be underlain by granitic rocks and paraconglomerate of the Gowganda Formation.

DUNCAN LAKE OCCURRENCES (17)

During the current mapping, occurrences of cobalt mineralization and hematite were observed along the northern part of Duncan Lake, and chalcopyrite at the southern part of the same lake in Knight Township.

Northern Duncan Lake

Hematite in a quartz vein occurs on an island in the northern part of Duncan Lake and is collinear with a similar vein on the east shore opposite the island trending on average N50W. The vein is 0.7 m wide, dips 75 degrees to the north, and consists of quartz-hematite breccia and a quartz-sandstone breccia. On the island it is 30 m long and its easterly extension, on the eastern shore of Duncan Lake, is about 20 m long. Hematite forms about 30 percent of the vein and cements the quartz and sandstone fragments.

An occurrence of hematite 0.1 km east-southeast of the island referred to above and on the east shore of Duncan Lake consists of narrow ramifying hematized quartz veins in paraconglomerate.

About 0.7 km south of the same island referred to above and 120 m inland from the east shore of Duncan Lake is an occurrence of specular hematite, ruby silver (as small grains 0.5 mm across), cobalt bloom, and malachite in a quartz breccia vein containing fragments of pink arkose. The vein is enclosed in arkose of the Gowganda Formation near its contact with a Nipissing-type diabase sill. No exploration activity was detected at the occurrences.

Southern Duncan Lake

On the east shore of the southern part of Duncan Lake near the southern boundary of Knight Township, copper in the form of chalcopyrite was observed in a quartz stringer in the lower part of the Nipissing diabase sill at its contact with Gowganda Formation interlayered siltstone-mudstone units. The chalcopyrite occurs as disseminated grains about 2 mm in width and forms 5 percent of the stringers. No exploration activity was noted.

GUARANTY TRUST COMPANY OF CANADA (18)

In 1974 Guaranty Trust Company of Canada held one leased surveyed claim in northeastern Knight Township near its northern boundary with Raymond Township, on Duncan Lake. The claim is numbered GG 3004 and formed part of four claims held by L.L. Coulis in 1939.

The claim is underlain by Nipissing diabase and Gowganda arkose and pebbly arkose. The reported economic feature of interest consists of two intersecting veins 0.8 m wide, one striking N64E, the other N22E. These two veins intersect near the west central part of the claim. Some trenching and pitting was done on the more easterly vein in 1939 by L. Coulis and the mineralized sample was assayed for silver and gold. The best assays were reported to be 131 ounces silver per ton, and 3.50 ounces gold per ton (Resident Geologist's files, Ontario Ministry Natural Resources, Kirkland Lake).

C.F. HURST (1931) (19)

In 1931, C.F. Hurst staked and held six contiguous unpatented claims on the northeast shore of Pigeon Lake northeast of Brush Lake, in the southwestern part of the township. The claims were not in good standing in 1974.

Two quartz veins were found on the claim group, one of which lies on the Wahbic Explorations Limited property (24) and is described thereunder. The other quartz vein is now on open ground. This vein was not visited during the current mapping but was described by Graham (1932, p.60) as follows: "The . . . quartz vein was discovered on the east side of claim GG.6084 and trenched for approximately 20 feet, showing a maximum width of 2 feet

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along this exposed length. Though much chalcopyrite is associated with the quartz, the gold values were found to be low."

METIKEMEDO MINES LIMITED (20)

In 1974 Metikemedo Mines Limited held six contiguous surveyed claims numbered MR 34254, 34257, 34258, 34259, 34261 and 34262 located in southwestern Knight Township. This property formed part of an original claim group staked in 1933 by an unknown person, part of a group held by D.H. Gardner in 1936, part of the Courageous Gold Mines Limited property held in 1959 and part of the New Senator-Rouyn Limited property of 1964.

The most important occurrence was located on claim MR 34262 and was described in the company reports as follows: "The most important showing is a 20 foot carbonated porphyry dike containing numerous quartz stringers and mineralized with finely crystalline pyrite. It strikes N20W and appears to be on a contact between peridotite and chloritic greenstone" (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). The dip of the dike was said to be 70W. The deposit was exposed by trenching in 1936 when arsenopyrite was found associated with the pyrite. The best assay from channel sampling by Erie Canadian Mines Limited, who held an option on the property in 1936, was 2.00 ounces Au per ton over 0.58 m (Resident Geologist's files, Kirkland Lake). The option was allowed to lapse as the results were considered disappointing.

In 1959 Courageous Gold Mines Limited drilled 15 short diamond drill holes for a total length of 344.9 m on claim MR 34254, 200 m southeast of the showing. Andesite was the main rock type encountered in the holes with very minor rhyolite. Numerous quartz and quartz-carbonate veins and veinlets were also encountered. The best gold assay from the drilling was \$16.80 per ton in gold over 1.1 m (gold at \$33.57 per ounce, 1959 price) (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake).

In 1964, on claim MR 34258 on the northeastern part of the property, New Senator-Rouyn Limited drilled five diamond drill holes for a total of 329 m. The predominant rock type encountered in the holes was andesite associated with rhyolite, and chlorite-talc schist. Quartz and quartz-carbonate veins were very common. The best gold assay was 0.07 ounces per ton over 0.75 m (Resident Geologist's files).

In 1966 W.D. Sutherland and Associates drilled four holes on the eastern part of the property on claims MR 34257 and 34258. Quartzite, trachyte, peridotite, andesite and rhyolite, and diabase and diorite dikes were intersected, associated with graphitic sedimentary rocks. Mineralization consisted of pyrite, pyrrhotite, and mariposite. Quartz veins and carbonate stringers were intersected. No assays of the core were recorded.

In 1967 Timiskaming Nickel Limited diamond drilled five holes for 972 m on claims MR 34257 and 34254 on the eastern part of the property. Peridotite was the most prevalent rock type encountered in the drilling. It was associated with diabase, diorite, rhyolite, and a lamprophyre dike. Mineralization consisted of disseminated pyrite and pyrrhotite. No assays of the mineralized core are recorded.

FOLLIWOG LAKE OCCURRENCE (21)

Copper occurring as chalcopyrite and secondary malachite was located in a dark grey quartz vein 15 cm wide exposed in a pit in diabase in southeastern Knight Township. The strike of the vein was N80E. The dip of the vein was not ascertainable.

TIMISKAMING NICKEL LIMITED (22)

In 1974 Timiskaming Nickel Limited held a group of 68 claims all in southwestern Knight Township. Eighteen of these were surveyed claims numbered: MR 44384, 44385, 43516-

43519, 44415-44417, 44421-44427, 44483, 39596-39597, and 44479, and 50 were unsurveyed claims. This group of claims included surveyed claims formerly held by other owners.

Current mapping shows that the claim group is underlain by Early Precambrian ultramafic and subalkalic and alkalic metavolcanics which are intruded by granitic and diabasic rocks and unconformably overlain by clastic sedimentary rocks of the Middle Precambrian Gowganda Formation. Ultramafic metavolcanics are the most abundant, but alkalic metavolcanics are only just less so.

The exploration work was carried out in four areas: (1) to the northwest of Moon Lake; (2) in the neighbourhood of a small lake 0.8 km west-southwest of Brush Lake; (3) at Brush Lake; and (4) in the southwestern part of the township.

Area Northwest of Moon Lake

In this area the economic features of interest are four gold-bearing shears (referred to herein as the No. I, II, III, and IV deposits) which constitute the showings. The No. I deposit is a shear 60 m long and 10-75 cm wide striking N25E, and containing quartz stringers and carbonatized bands mineralized with fine and coarse pyrite. The No. II deposit is 30 m long, 15 cm wide, striking N15E, and contains an 8 cm wide quartz vein in carbonatized breccia. The No. III deposit is described as a 10 cm wide massive sulphide zone in spherulitic lava in a weak shear of unknown dimensions striking N30W and dipping vertically (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). The No. IV deposit is described as a strong shear adjacent to which is 10 cm quartz vein consisting of two collinear veins totalling 15 m in length and striking north, enclosed in brecciated trachyte (Resident Geologist's files).

In 1939 Hollinger Consolidated Gold Mines Limited carried out trenching and sampling of these showings under the terms of their option agreement with A. Decker, owner of the property at the time, but it is not known on which deposit the work was actually done. Following this, in 1944, Camdeack Gold Mines Limited optioned the property from A. Decker and began a trenching and diamond drilling program.

By the middle of 1945 twenty-two holes had been completed for a total length of 625 m. Rocks encountered were described by the Resident Geologist at the Kirkland in 1945, J.W. McBean, as "trachyte, trachyte breccia, tuff and agglomerate in Temiskaming-like rocks, and fragmental, spherulitic lavas, breccia and agglomerate in Keewatin-like rocks" (Resident Geologist's files, Ontario Ministry Natural Resources, Kirkland Lake). McBean also reported the occurrence of one diabase dike and feldspar porphyry which was described as a reddish weathering rock with 1/4 inch hornblende phenocrysts locally. He concluded that a "large proportion of the trachyte mapped is tuff and agglomerate" (Resident Geologist's files). The Keewatin-type rocks were described as "chloritized green to brown weathering rocks subjected in some areas to extreme carbonatization and silification" (Resident Geologist's files). A chip sample taken by a Mr. Don Hurd from deposit No. I yielded \$7.32 (gold at \$38.50 per ounce, 1944-1945 price (Resident Geologist's files). A grab sample taken by an unknown person from deposit No. II returned a value at \$23.87 (gold at \$38.50 per ounce, 1944-1945) (Resident Geologist's files). A similar type of sample, also taken by an unknown person, from Deposit No. III returned \$34.26 (gold at \$38.50 per ounce, 1944-1945 price) (Resident Geologist's files). A 2.0 foot channel sample was reported by Don Hurd to have yielded \$11.55 (gold at \$38.50 per ounce, 1944-1945 price) from deposit No. IV (Resident Geologist's files).

In 1948, A. Decker trenched the No. III deposit and it was reported by W.S. Savage, Resident Geologist at Kirkland Lake, who was visiting the property, that visible gold was observed in the veins forming the deposit. In a description of the property in 1960, the No. I and II deposits together were referred to as the "east break" which was said to have been traced for "a length of 800 feet with widths from three to six feet" (Northern Miner July 20, 1960, p.2). Likewise, deposits No's. III and IV together were called the "west break", which was considered to be the more important "though it has been traced for only a few hundred

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feet as it lies in swampy ground and disappears under overburden at each end" (Northern Miner 1950). In 1950, Becnite Mines Limited cleaned out the old trenches and carried out sampling and diamond drilling. Nine diamond drill holes were put down at unspecified localities at the showings for a total length of 764 m. Andesite, rhyolite, green carbonate, trachyte and graphite were encountered and mineralization consisted of pyrite, chalcopyrite and pyrrhotite. The best assay result from the drill core was \$5.25 in Au over 38 cm (gold at \$38.05 per ounce, 1950 price) (Resident Geologist's files). Sampling of an unknown kind at an unspecified location returned a value of \$103.95 across 36 cm (gold at \$38.05 per ounce, Northern Miner 1950, p.2).

Later, in 1958, Wexford Mines Limited drilled five diamond drill holes probably on the No. IV showing. Rhyolite and trachyte were encountered in the holes and mineralization consisted of "very minor sulphides" (Resident Geologist's files). No assays were recorded.

Finally, in 1965, Initiative Exploration Limited, drilled six diamond drill holes for a total length of 799.5 m on the showings. Trachyte was the major rock-type encountered in the core and mineralization consisted of disseminated pyrite, chalcopyrite, and galena, with carbonate zones, rhyolite, green fuchsite, and irregular quartz and quartz-calcite veins. The best assay from the drilling was 0.145 ounces Au per ton over 0.3 m (Resident Geologist's files).

Area West-Southwest of Brush Lake

In the area 0.8 km west-southwest of Brush Lake, Timiskaming Nickel Limited drilled fourteen diamond drill holes totalling 1669 m in the first half of 1968 for nickel. During the current mapping a copper occurrence and an asbestos showing were observed in the area.

In the drilling carried out by Timiskaming Nickel Limited, trachyte, peridotite, diabase, Gowganda conglomerate and greywacke, feldspar porphyry, and rhyolite were intersected in the core. Sections of the core returned a best assay for nickel of 0.28 percent (Resident Geologist's files, Ontario Ministry Natural Resources, Kirkland Lake).

The copper occurrence is located 200 m southwest of Brush Lake and consisted of malachite staining on a carbonated shear 0.3 m wide, at the contact of serpentinite and grey, altered basalt. Chalcopyrite and pyrite occur as disseminated grains and patches from 0.1 to 2 mm across in light and dark grey calcite. The chalcopyrite forms about 0.5 percent of the rock. No evidence of exploration activity was observed on the occurrence.

The asbestos showing is located 0.8 km southwest of Brush Lake, and considerable exploration work consisting of stripping and blasting over an area 45 m long by 30 m wide was observed. Much of the drilling described above was also centred here. The exploration area revealed black serpentinite crossed by irregular, ramifying veins and stringers of asbestos varying from 1 mm to 25 mm wide consisting of soft cross-fibre asbestos. No record of this exploration work is given in the assessment work files.

Brush Lake Area

In the Brush Lake area, the earliest recorded exploration consisted of trenching carried out in 1935 on the property of J.B. Moynour, on the northeastern shore of the lake. The property was described (Resident Geologist's files, Ontario Ministry Natural Resources, Kirkland Lake) as "underlain by Keewatin greenstone somewhat brecciated and cut by bands of cherty material probably aplite or fine quartz porphyry". The main showing on which "very spectacular free gold" (Resident Geologist's files) was reported, consisted of "one such band striking N80E and dipping 50°N along the north shore" of the lake (Resident Geologist's files). "Several narrow quartz veins striking almost at right angles intersect, cut the greenstone and intersect the aplite on its footwall side. It was in one of these veins that the high-grade pocket was found" (Resident Geologist's files). It was reported by Mr. Moynour that "seventeen pounds of ore. . .yielded. . .\$800.00 when shipped to the Mint"

(Resident Geologist's files) (gold at \$35.19 per ounce, 1935 price). This was obtained from the main high-grade vein. Exploration work was carried out in the hope of locating an ore shoot, but the veins proved to be too far apart for mining, and the work was thus discontinued.

In 1937 Erie Canadian Mines Limited examined the occurrence, presumably for gold, on the property of Big Divide Gold Mines Limited near the southeastern shore of Bush Lake along the eastern bank of Milly Creek. The showing consisted of a shear vein trending N20W in granodiorite. No further work was undertaken.

Finally in 1967 two diamond drill holes were drilled by Timiskaming Nickel Limited totalling 225 m, one near the northern end of the lake, the other at the northeastern shore. The objective of the drilling was not indicated but the occurrence of gold on the Moyneur property just described may have prompted the work. The hole on the northeastern shore intersected rhyolite, peridotite, an apite and a granite dike, and Cobalt sedimentary rocks. Mineralization consisted of pyrite and pyrrhotite. The hole on the northern end of the lake intersected peridotite with minor rhyolite. No assay data are available in the company's files.

During the current mapping a grab sample from dark fine-grained vein material from the trench on the northeast shore of Brush Lake gave the following assay results: Cr 0.5 percent, Cu 0.04 percent, Ni 0.19 percent as determined by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

On the southwestern shore of the southern arm of Pigeon Lake where it leads into Brush Lake, a rock classed as hawaiite in the classification of Irvine and Baragar (1971) contains 10 percent pyrite occurring in planar fractures up to 4 mm wide and is stained with pink cobalt bloom. A grab sample of this rock when assayed by the Geoscience Laboratories, Ontario Geological Survey, gave the following results: Ag 0.13 ounces per ton, Cu 0.02 percent, and Ni 0.02 percent.

Southwestern Knight Township

In the latter part of 1968 an airborne geophysical survey comprising an in-phase and out-of-phase electromagnetic method was carried out by Lockwood Survey Corporation Limited for Timiskaming Nickel Limited in parts of Knight and Natal Township. Three small anomalous areas were found: (1) associated with the ultramafic rocks southwest of Pigeon Lake; (2) associated with a gold occurrence on the northeast shore of Pigeon Lake; and (3) "indicating a relatively good conductor at depth" (Resident Geologist's files, Ontario Ministry Natural Resources, Kirkland Lake), to the southwest of Pigeon Lake and apparently associated with the ultramafic rocks in that area. A pronounced north-trending feature more or less coincident with the West Montreal River to the north of Arthur Lake was noted. Current mapping shows that a fault coincides with the river in this area. No follow-up work to the geophysical surveys was recorded.

TYRANITE MINES LIMITED (2)

In 1974 Tyrante Mines Limited held four surveyed claims at Spade Lake near the middle part of the south boundary of Knight Township, numbered GG 5800, 5803, 5815 and 5816. This formed part of the original group of six claims (Graham 1932, p.49), straddling the boundary with Tyrrell Township, staked and owned by L.O. Hadlund of Gowganda in 1930. The property was subsequently optioned to J.C. Waite in June, 1931, then to Ventures Limited and Nipissing Mining Company jointly in September, 1931, and later to M.J. O'Brien in December, 1931. The option to M.J. O'Brien was allowed to lapse in 1932. In 1934 Consolidated Smelters held an option on the property which was, however, allowed to lapse in 1935. In 1936 Tyrante Gold Mines Limited took over the property and is the present owner.

Exploration work on the property began in 1930 and consisted of trenching and dis-

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mond drilling in Knight Township. This work was carried out by L.O. Hedlund, J.C. Waite, Ventures Limited, Nipissing Mining Company, M.J. O'Brien, Consolidated Smelters, and Tyrant Gold Mines Limited. Fifteen diamond drill holes of unknown total length were sunk in Knight Township by an unknown group.

In Knight Township the deposit is located on claim GG 5800 and it extends into claim GG 5801 in Tyrrell Township to the south. It was described as lying in a fracture zone trending N10W and dipping 70 degrees west, parallel to a contact of granitic and basaltic rocks. Mineralization along the fracture extended for 120 m north from the common Knight-Tyrrell Townships boundary line and formed a zone approximately 9 m wide. The fracture zone was highly silicified, containing numerous quartz and carbonate veinlets filling small fractures and impregnated with "pyrite in irregular particles and in cubic crystals. The gold values are contained chiefly in this sulphide. ..." (Graham 1932, p.51). No specific assay values for this section of the mineralized zone in Knight Township were given but exploration in Tyrrell Township led to the development of the Tyrant mine, which operated from 1939 to 1942 (Carter 1977b, p.55-56).

WAHBIK EXPLORATIONS LIMITED (2A)

In 1974 Wahbic Explorations Limited held 18 claims at Pigeon Lake in west-central Knight Township consisting of fifteen surveyed claims, numbered: GG 6082, 6083, 6202, 6203, MR 40025, 40027, 40028, 40029, 40035, 40036, 40738, 40039, 40040, 40041, 43109, and three unsurveyed claims. This property included part of the Hurst property (Graham 1932, p.59) staked by Charles F. Hurst of North Cobalt in 1931, and later optioned to R.E. Hore in August of the same year. It also includes the property formerly held by Whitegate Mining Company Limited.

The showing occurring on the current Wahbic Explorations Limited property is a quartz vein. This vein, "which is situated on the small point in claim G.G.6083, lies in a fracture zone in granodiorite, strikes N.6°E, and dips 80°W. The walls of the vein are irregular and contorted, indicating that there was considerable movement along the fracture zone subsequent to the intrusion of the vein. It is faulted at two points, with a horizontal displacement of about 10 feet in both cases. Surface trenching has shown the vein to continue for 150 feet across the point of land, with the width ranging from 3 inches to 2½ feet. The owner reported that one channel sample across 8 inches of the vein assayed \$16.20 in gold per ton, and that two other samples, taken across 4 feet of the fracture zone, with approximately 2 feet of the quartz vein represented in the samples, assayed 20 cents and \$4. Visible gold was found at two points. The vein is mineralized with pyrite, chalcopyrite, and considerable molybdenite" (Graham 1932, p.60). The price of gold in 1931 was \$21.57 per ounce.

In 1985 Whitegate Mining Company drilled four holes on the property at Pigeon Lake: three of these holes were located on the northeastern shore of the lake near the northwest corner of claim MR 40029, and the fourth was near the northeastern shore of the promontory at the southern end of Pigeon Lake on claim MR 40025. The logs for only two of these holes are available and they indicate a total length of drilling of 382 m. The purpose of this drilling was to intersect two parallel northwest-trending shear zones reported (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake) to be mineralized with pyrite, gold and copper. The third and fourth holes of these intersected mostly serpentinized peridotite, carbonate rock, and graphite schist. Mineralization in both these holes consisted of pyrite, pyrrhotite and sulphides (Resident Geologist's files). The core was assayed for gold and the best assay was 0.07 ounces per ton over 2 m (Resident Geologist's files). Two further holes were drilled in 1987, one on claim MR 40027 and one on MR 40025 for a total length of 316 m. These holes encountered mainly peridotite with associated granodiorite, andesite, and feldspar porphyry. No assays for this core were reported.

In 1988 Wahbic Explorations Limited diamond drilled three holes totalling 487 m on the

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property. These holes encountered mainly peridotite with minor feldspar porphyry, rhyolite and trachyte. No assay results were reported.

A. ZANELLA (25)

In 1974, A. Zanella held one surveyed claim numbered MR 11485 located 0.8 km north-west of Spade Lake near the middle of the south boundary of Knight Township.

No assessment work has been filed for the claim but current mapping has shown it to be underlain by the Milly Creek granitoid pluton which is gold bearing.

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NATAL AND KNIGHT TOWNSHIPS

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NATAL AND KNIGHT TOWNSHIPS

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LEGEND

PHANEROZOIC

CENOZOIC*

QUATERNARY

PLEISTOCENE AND RECENT

Sand, gravel, swamp deposits, alluvium.

UNCONFORMITY

PRECAMBRIAN*

MIDDLE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (Nipissing Type)

- 11a Diabase, medium grained.
- 11b Diabase, coarse-grained.
- 11c Leucodibase.
- 11d Diabase, fine-grained.

INTRUSIVE CONTACT

HURONIAN SUPERGROUP

COBALT GROUP

GOWGANDA FORMATION

- 10a Argillite.
- 10b Slate.
- 10c Siltstone.
- 10d Arenite.
- 10e Paraconglomerate.
- 10f Wacke.
- 10g Orthoconglomerate.
- 10h Quartz-hematite-arenite breccia.
- 10j Gravelly arenite.
- 10k Siltstone-mudstone.
- 10m Mudstone.

UNCONFORMITY

EARLY PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (Matachewan Type)

- 9a Diabase, medium-grained.
- 9b Diabase, fine-grained.
- 9c Diabase, porphyritic.
- 9d Leucodibase.
- 9e Diabase, granophyric.

INTRUSIVE CONTACT

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

- 8 Unsubdivided.
- 8a Grey hornblende-biotite granitoid rocks.
- 8b Pink hornblende-biotite granitoid rocks.
- 8c Porphyritic feldspar-hornblende granitoid rocks.
- 8d Granitoid-basalt contact rocks.

INTRUSIVE CONTACT

METASEDIMENTS

- 7a Chert.
- 7b Greywacke.

METAVOLCANICS

ALKALIC METAVOLCANICS

Intermediate Metavolcanics

- 6a Flows, aphanitic.
- 6b Flows, porphyritic.
- 6c Tuff.
- 6d Lapilli-tuff.
- 6e Tuff-breccia.

Mafic Metavolcanics

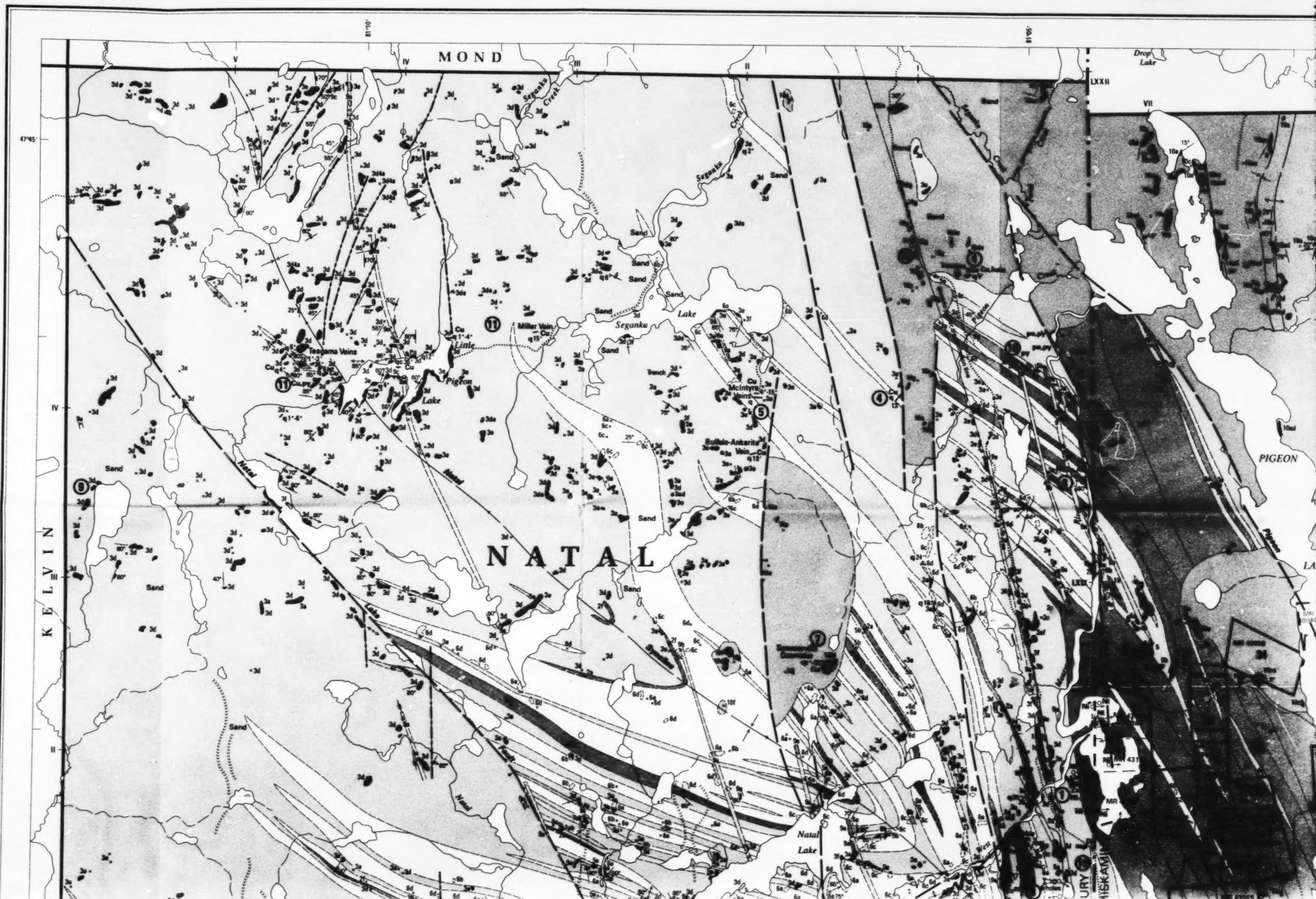
- 5 Unsubdivided.
- 5a Flows, aphanitic.
- 5b Flows, porphyritic.
- 5c Tuff.
- 5d Lapilli-tuff.
- 5e Tuff-breccia.

SUBALKALIC METAVOLCANICS

THOLEIITIC AND CALCALKALIC METAVOLCANICS

Felsic Metavolcanics

- 4a Flows, aphanitic.
- 4b Flows, porphyritic.
- 4c Tuff.
- 4d Lapilli-tuff.



NTS Reference 41P/10 41P/11 41P/14
41P/15

	Glacial striae drumlin.
	Esker.
	Bedrock; (small outcrop, area of outcrop).
	Bedding, horizontal.
	Bedding, top unknown; (inclined, vertical).
	Bedding, top indicated by arrow; (inclined, vertical, overturned).
	Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).
	Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).
	Bedding, top (arrow) from relationship of cleavage and bedding; (inclined, overturned).
	Lava flow; top (arrow) from pillows shape and packing. Lava flow; top in direction of flow.
	Direction of paleocurrent.
	Schistosity; (horizontal, inclined, vertical).

- 6d Lapilli-tuff.
6e Tuff-breccia.
- Mafic Metavolcanics
- 5 Unsubdivided.
5a Flows, aphanitic.
5b Flows, porphyritic.
5c Tuff.
5d Lapilli-tuff.
5e Tuff-breccia.

- SUBALKALIC METAVOLCANICS
- THOLEIITIC AND CALCALKALIC METAVOLCANICS
- Felsic Metavolcanics
- 4a Flows, aphanitic.
4b Flows, porphyritic.
4c Tuff.
4d Lapilli-tuff.

- Intermediate Metavolcanics
- 3a Flows, aphanitic.
3b Flows, porphyritic.
3c Flows, pillowed.
3d Tuff.
3e Lapilli-tuff.
3f Tuff-breccia.
3g Breccia.

- Mafic Metavolcanics
- 2 Unsubdivided.
2a Flows, fine-grained, aphanitic.
2b Flows, pillowed.
2c Flows, amygdaloidal.
2d Flows, coarse-grained.
2e Flows, porphyritic.
2f Tuff.
2g Flows, variolitic.
2h Lapilli-tuff.
2j Flows, light grey brecciated in places.
2k Amphibolite.

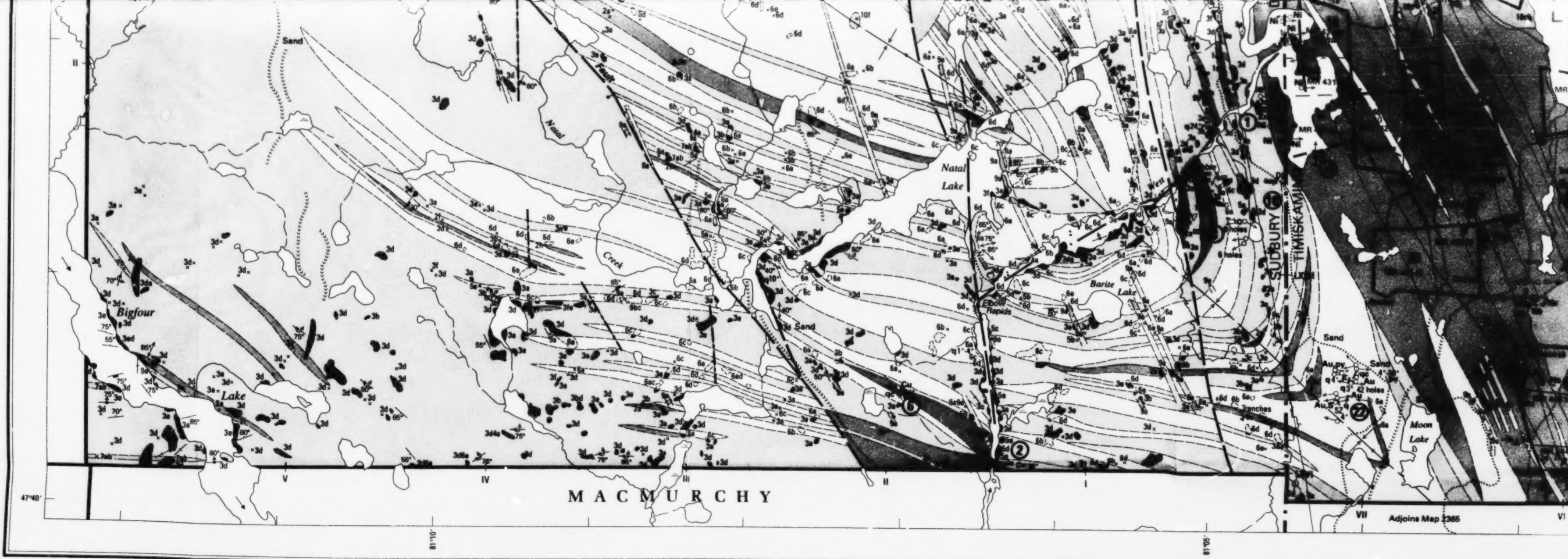
- KOMATIITIC METAVOLCANICS
- Ultramafic and Basaltic Komatiites
- 1 Unsubdivided.
1a Dunitic komatiite, serpentinized, black.
1b Serpentinite, light green.
1c Serpentinite-carbonate breccia.
1d Serpentinite, dark green.
1e Peridotitic komatiite, spinifex textured.
1g Hornblende-wehrlite.
1h Serpentinite, grey.
1j Green carbonate.
1k Variolitic, serpentinized, peridotitic komatiite.
1m Basaltic komatiite.
1n Lapilli-tuff.

Mineralized zone

- Ag Silver.
asb Asbestos.
asp Arsenopyrite.
Au Gold.
calc Calcite.
Co Cobalt.
Cr Chromium.
Cu Copper.
hem Hematite.
Mo Molybdenum.
Ni Nickel.
po Pyrrhotite.
py Pyrite.
q Quartz.
qc Quartz-carbonate.
s Sulphide mineralization.
Zn Zinc.

Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured parts of the map.

Bedrock geology. Outcrops and inferred extensions of each rock unit are shown respectively in deep and light tones of the same colour.



Published 1983

SOURCES OF INFORMATION

Geology by M.W. Carter and assistants, Ontario Geological Survey, 1974.
Geology is not tied to surveyed lines.

Resident Geologist's Files, Ministry of Natural Resources, Kirkland Lake.

Aeromagnetic maps (OGS-GSC) 284G, 285G, 286G, 287G.

Geological Survey of Canada map 64A.

Ontario Department of Mines.
Map 35j, Grassy River Area, 1926.
Map 41b, Tyrrell-Knight Area, 1932.
Map 2205, Timmins-Kirkland Lake Sheet, 1973.

Preliminary Maps (OGS)
P151, Gogama Sheet, scale 1 inch to 2 miles, 1962.
P1036, Natal Township, scale 1 inch to 1/4 mile, 1975.
P1037, Knight Township, scale 1 inch to 1/4 mile, 1975.

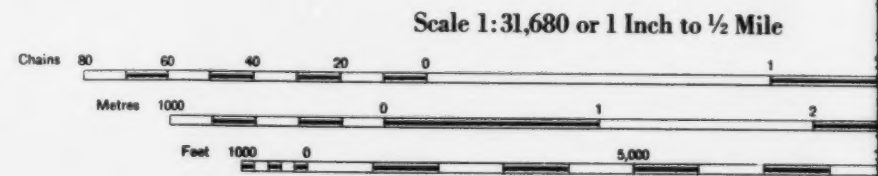
Cartography by P.A. Wisbey and assistants, Surveys and Mapping Branch, 1982.

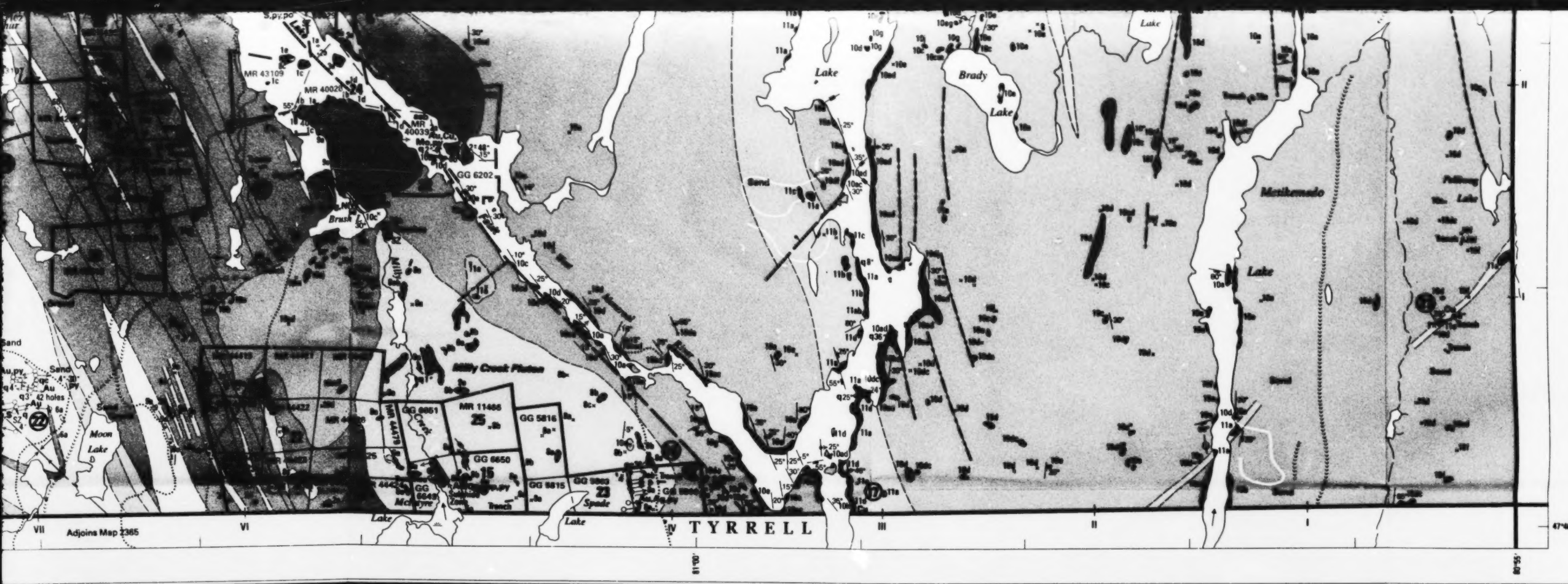
Basemaps derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch, with additional information by M.W. Carter.

Magnetic declination in the area was approximately 8° 45' West in 1974.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:
Carter, M.W.
1983: Natal and Knight Townships, Ontario Geological Survey Map 2465, Precambrian Geology Series, scale 1 inch to 1/4 mile, geology, 1974.

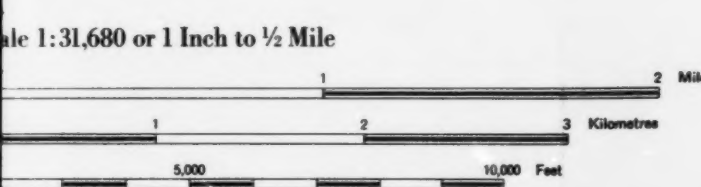
Ontario Geological Survey Map 2465 NATAL AND KNIGHT TOWNSHIPS SUDBURY AND TIMISKAMING DISTRICTS.





- Bedding, top indicated by arrow; (inclined, vertical, overturned).
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).
- Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).
- Bedding, top (arrow) from relationship of cleavage and bedding; (inclined, overturned).
- Lava flow; top (arrow) from pillows shape and packing. Lava flow; top in direction of arrow.
- Direction of paleocurrent.
- Schistosity; (horizontal, inclined, vertical).
- Gneissosity; (horizontal, inclined, vertical).
- Foliation; (horizontal, inclined, vertical).
- Banding; (horizontal, inclined, vertical).
- Lineation with plunge.
- Geological boundary; (observed, position interpreted, deduced from geophysics).
- Magnetic contour value in gammas. Magnetic attraction.
- Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
- Lineament.
- Jointing; (horizontal, inclined, vertical).
- Drag folds with plunge.
- Anticline, syncline, with plunge.
- Drill hole; (vertical, inclined, projected vertically, projected up dip). Overburden shown.
- Location of sample.
- Vein, vein network. Width in inches or feet.
- Radioactivity.
- Swamp.
- Motor road. Provincial highway number encircled where applicable.
- Other road.
- Trail, portage, winter road.
- International or Provincial boundary.
- County, District, Regional or District Municipal Boundary, with mile post.
- Municipal Boundary, (City, Town, Improvement District, Incorporated Township), with milepost.
- Township, Indian Reserve, Meridian, Base Line, Provincial Park, with milepost, (surveyed, unsurveyed).
- Mining property, surveyed. Mineral deposit or mining property, unsurveyed.
- Surveyed line.
- Unsurveyed line.

Ontario Geological Survey
 Map 2465
KNIGHT TOWNSHIPS
 TYRRELL AND TIMISKAMING DISTRICTS



PROPERTIES, MINERAL DEPOSITS

NATAL TOWNSHIP

1. Arthur Lake Mines Ltd.
2. Ecstall Mining Ltd.
3. Fuller, A [1945].
4. McIntyre Porcupine occurrences.
5. Nabigon, P.
6. Natal Lake occurrence.
7. Sommerville occurrence.
8. Sutherland, W.D. and Associates [1966].
9. Talisman Mines Ltd. [1967].
10. Timiskaming Nickel Ltd. [1967].
11. Whyte, A.

KNIGHT TOWNSHIP

12. Amax Potash Ltd. [1971].
13. Arthur Lake Mines Ltd.
14. Courageous Gold Mines Ltd. [1959].
15. Dalhousie Oil Co. Ltd.
16. Decker, A.
17. Duncan Lake occurrence.
18. Guaranty Trust Co. of Canada.
19. Hurst, C.F. [1931].
20. Metikamedo Mines Ltd.
21. Pilliwog Lake occurrence.
22. Timiskaming Nickel Ltd.
23. Tyrante Mines Ltd.
24. Wahbic Explorations Ltd.
25. Zanella, A.

Information current to December 31, 1974.

Former properties on ground now open for staking are only shown if exploration data is available. A date in square brackets indicates last year of exploration activity. For further information see report.

All boundary and survey lines are approximate position only.
 Some symbols may not occur on this map.

POOR

QUALITY

ORIGINAL

